POWER and THE ENGINEER

EVERYTHING ABOUT THE GENERATION AND TRANSMISSION OF POWER

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MR. ENGINEERMAN, did it ever occur to you that perhaps you were not making the best of your opportunities?

A wise old Captain of Industry once said that a man to earn promotion and pay must make himself "conspicuously useful."

Don't hide behind the boiler when the boss comes into the engine room.

Remember that the boss is a business man, however little he knows about steam engineering.

Business men are looking for chances to *save money.*

You don't have to argue for anything very long when you can prove to a business man that a certain device, material or practice will make or save *his* money.

A large manufacturer said, in this office, just the other day, that his engineers had never suggested the purchase of any equipment, save small supplies, to make the plant better or more economical.

He said: "*I* read POWER and suggest to them ways and means. *I* ask 'em if this, that or the other thing wouldn't save coal."

There it is,—there's the opportunity.

George Daniels, some time General Passenger Agent of the New York Central, once said to the writer: "Do you know that an engineer or conductor of our fast trains has never suggested a faster service—some ticket agent or newspaper did that."

When you read the claims and guarantees of some of the advertisers in this paper, for equipment that you are convinced would save the boss money, don't wait for a salesman to get him to thinking about it. That is *your* job.

Put it up to the Old Man.

He may not do all the things you ask him to, but he will do some of them. Suggest such things as will make a show of economy and go after it.

When he discovers that you are looking out for *his* interests and *his* cash you will soon cease to be merely the man that watches the engine. You will be his consulting engineer and he won't let you go for any small difference in salary.

Men in business are always looking out for saving and gain—else they are not real business men.

Go into partnership with the firm so far as your department goes.

Take the advertisement, the catalog, the price and the saving—so that you make a case the first time and—

Put it up to the Old Man.

If it doesn't make a dent in him it will make you a better power plant manager for having posted yourself on these subjects.

But it *will* make a dent—

Put it up to the Old Man!

Small Isolated Producer Gas Plant

An Efficient Installation of the Middle West. Simple and Convenient Arrangement for Coal Handling a Feature

BY OSBORN MONNETT

A producer-gas plant which is notable for the simplicity and convenience of the coal-handling arrangements and the continuous service rendered, has lately been installed by R. R. Street & Co., in the establishment of the Goodman American Ice Cream Company, Chicago. The equipment consists of two Wile suction-gas producers, one of 100 and one of 115 horsepower rated capacity, furnishing gas to two Bruce-McBeth four-cylinder vertical engines, also of 100 and 115 rated horsepower, respectively; both engines are belted to York horizontal double-acting ammonia compressors. The compressor driven by the smaller engine is of 30 tons refrigerating capacity, and the larger one of 40 tons. In addition a jack shaft is provided, from which is belted a 30-kilowatt, three-phase Westinghouse generator, furnishing light and

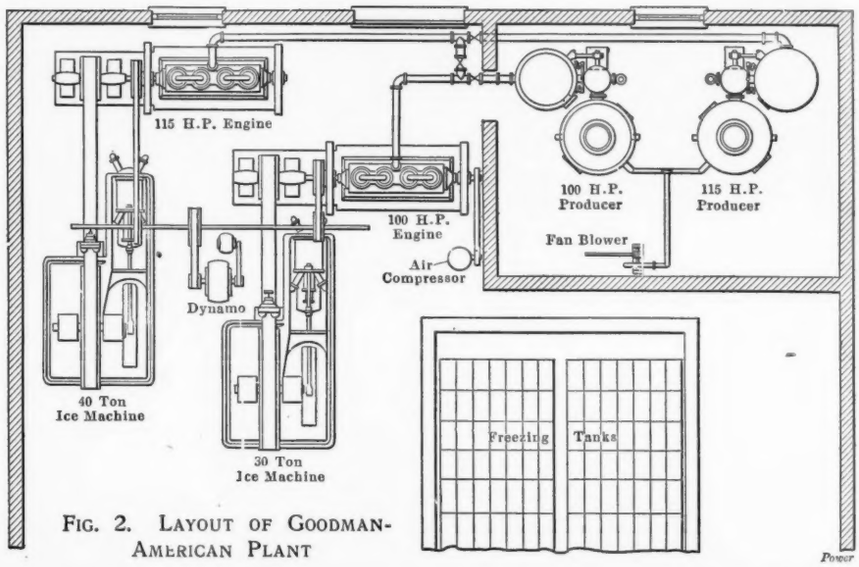


FIG. 2. LAYOUT OF GOODMAN-AMERICAN PLANT

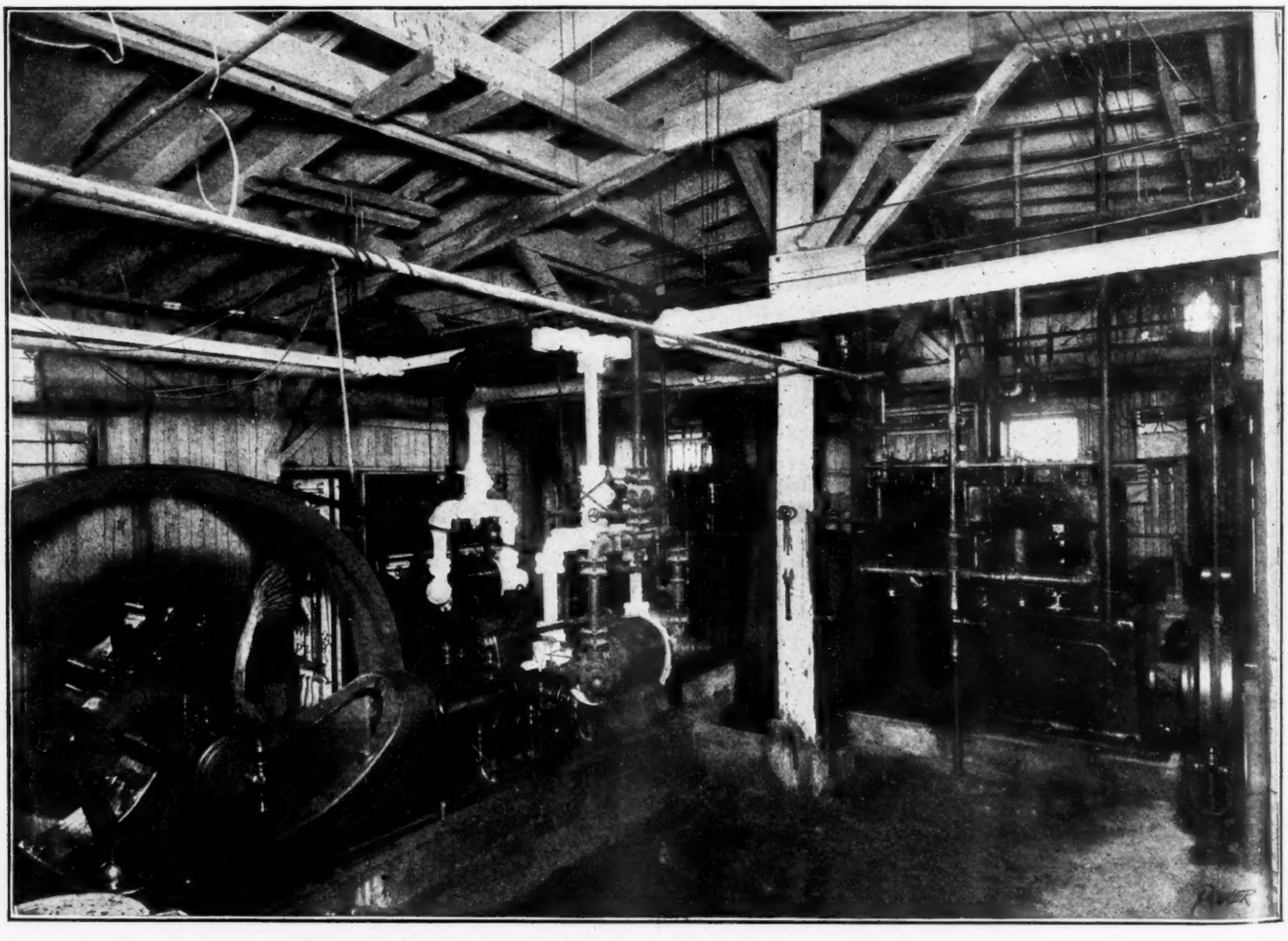


FIG. 1. VIEW IN ENGINE ROOM OF GOODMAN-AMERICAN COMPANY

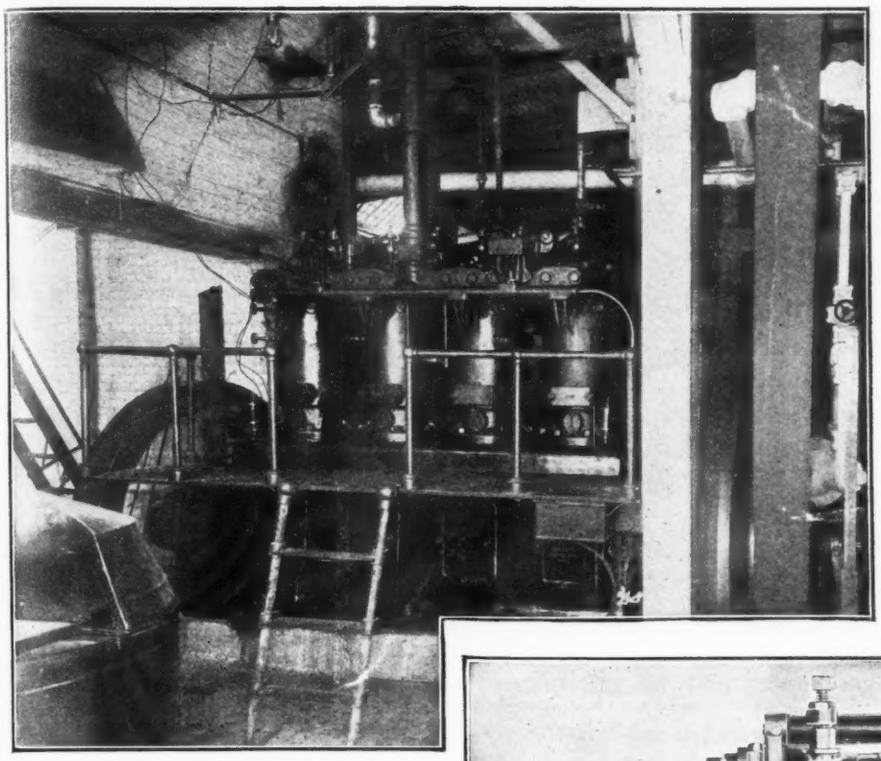


FIG. 3. FRONT VIEW OF ONE OF THE ENGINES

power throughout the establishment at 220 volts potential. Either of the engines, or both, may drive the jack shaft, through belts and friction-clutch pulleys.

The plant is in operation practically 24 hours per day for long periods and all cleaning of the fires is done without interrupting the service. Anthracite pea coal is used and a brake horsepower is developed on approximately one pound of coal.

The producer room is a steel and concrete structure, the upper part of which forms a coal bunker with a capacity of 40 tons. It is located adjacent to the elevated tracks of the L. S. & M. S. railway, and on account of this circumstance, coal may be loaded into the bunker from the cars without additional handling. A swinging spout delivers coal from the bunker to either producer, making the operation of charging fuel a very simple matter.

The producers have all the characteristics of the latest Wile design, including the flash type of vaporizer, consisting of a cylindrical shell containing two coils of pipe, one nesting within the other, as shown in Fig. 5. The water is fed into these two pipe helices and vaporized therein by the heat from the gases in the surrounding drum, through which they pass to the scrubber.

As the volume of water in the vaporizer is small, steam is available for making gas immediately upon starting the generator. Hydraulic purge and operating valves, and the Wile water regulators are also part of the equipment; these have been described in full detail in a previous issue of POWER AND THE ENGINEER.

Fig. 2 shows the general layout of the plant and indicates the manner in which the producers are interconnected so that either one may serve either engine. Six-inch pipes extend from the scrubbers to the cross-valve connection, and from this point 4-inch pipes lead to the engines. These are of the new four-cylinder design of the Bruce-McBeth Engine Company, of Cleveland, Ohio.

Spur and bevel gears drive a vertical shaft upon which the flyball governor is mounted (see Fig. 3). From this shaft individual cam shafts over each cylinder derive their motion. The element of duplication has been fully developed in the design of the engines; each cylinder is a duplicate of the others, and this is also true of the inlet and exhaust valves and the rocker arms which operate them.

Double jump-spark ignition is used,

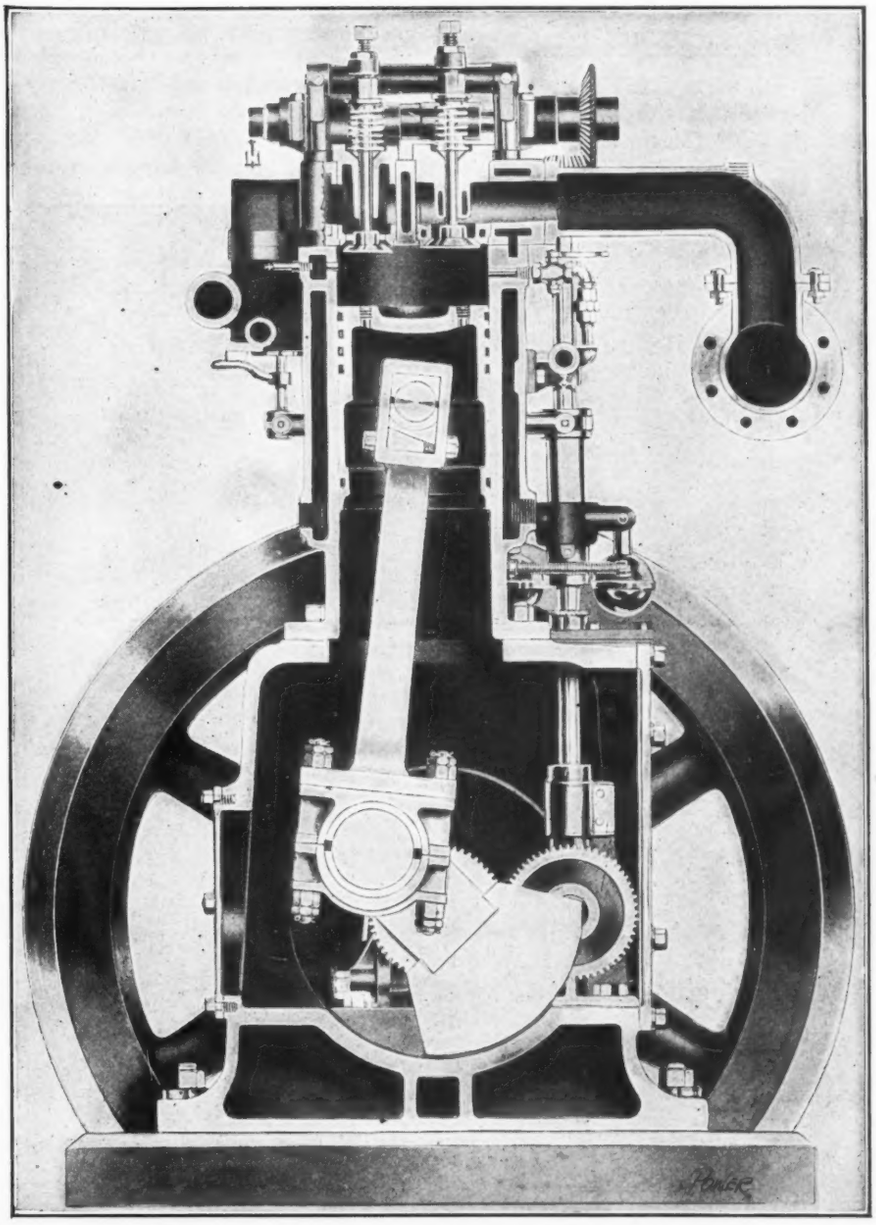


FIG. 4. VERTICAL SECTION THROUGH CRANK AND ONE CYLINDER

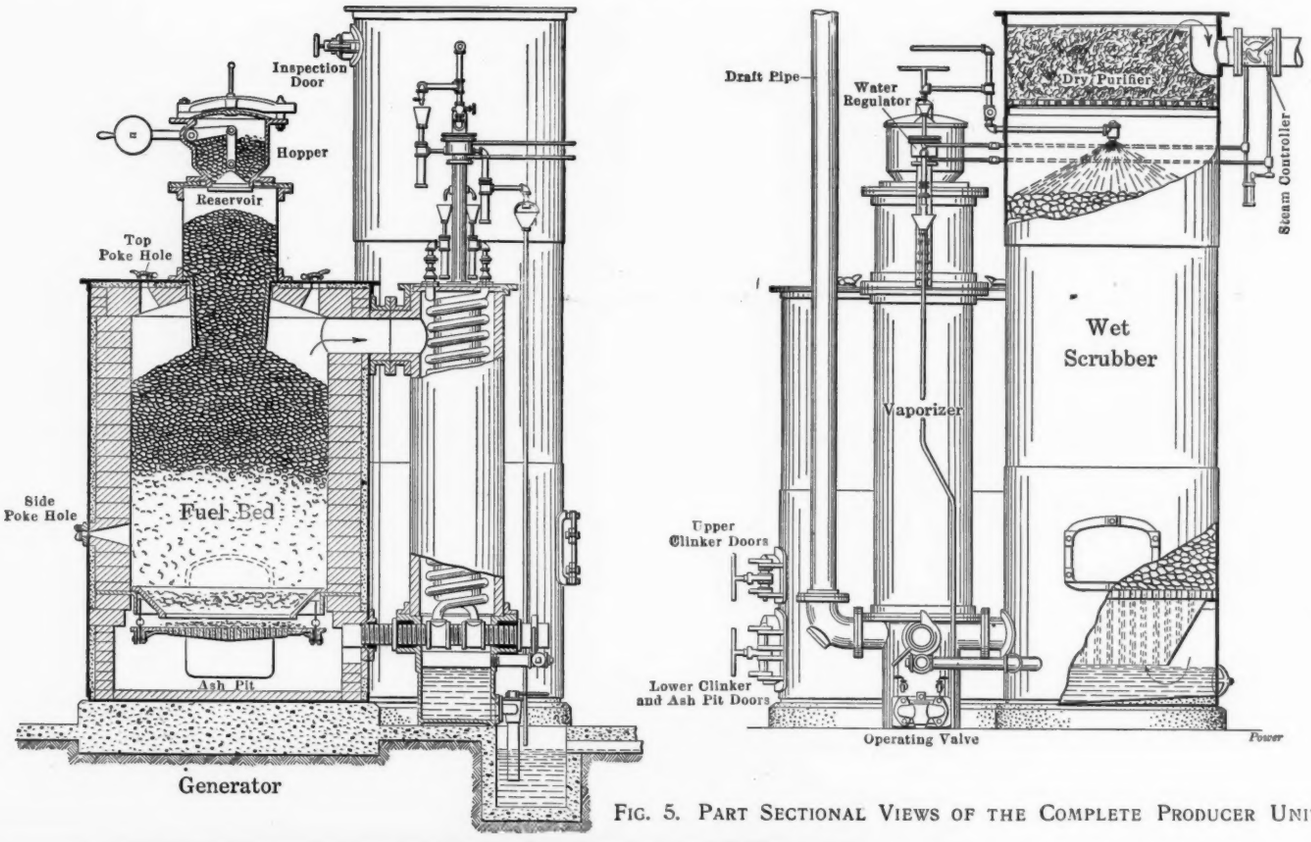


FIG. 5. PART SECTIONAL VIEWS OF THE COMPLETE PRODUCER UNIT

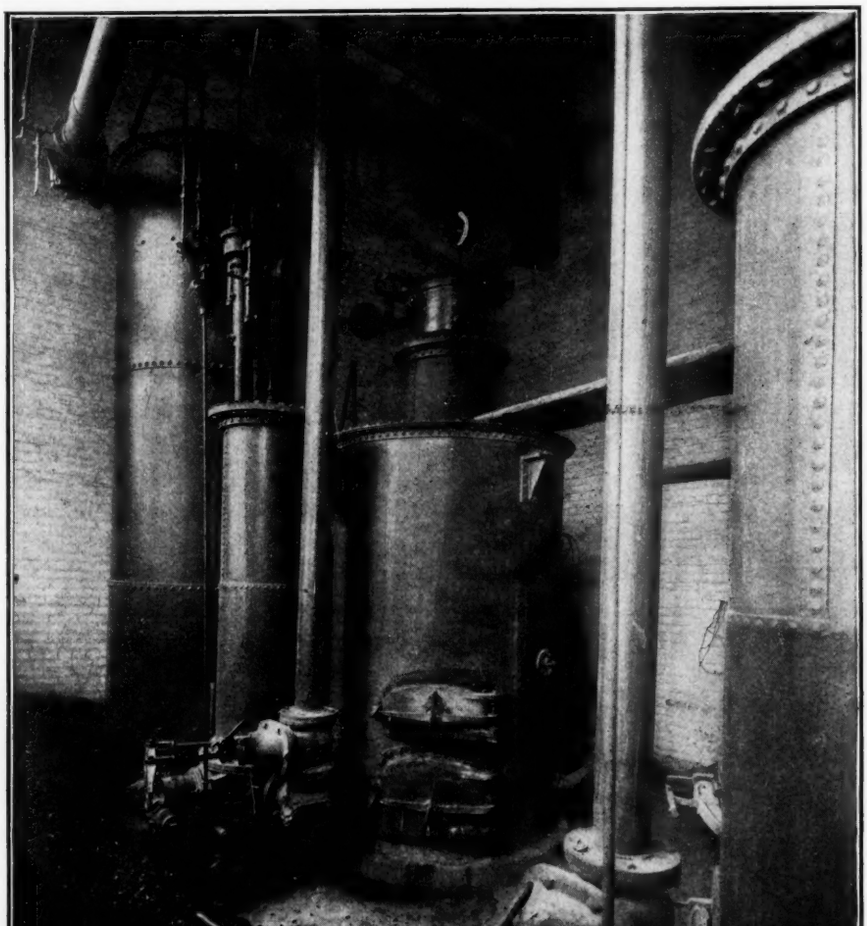


FIG. 6. THE LARGER GAS PRODUCER IN THE GOODMAN-AMERICAN PLANT

two systems being in service simultaneously. An eight-volt magneto belted to the shaft is the primary source of current. In addition there is provided for each engine a battery of storage cells in duplicate, one set being charged from the exciter circuit of the dynamo while the other is in use. A unique feature of the engines is their double equipment of ignition timers. Each cylinder is furnished with two sparks, each one being independent of the other, and each timer receiving current from a separate source. Any timer may be removed for repairs without affecting the operation of the engine, and by throwing the valve gear out of service on any cylinder the spark plugs may be taken out and replaced while the engine is running.

In the operation of the plant the output of the 30-ton machine is used for the hardening and cold storage of ice cream. This is accomplished through the circulation of calcium chloride brine by means of a motor-driven triplex pump. A total equipment of 39 horsepower in motors serves to operate the freezers, fans, ice crushers, blowers and pumps.

The larger refrigerating machine is used in making can ice, all of which is needed for packing the factory output in wagons and freezers for delivery.

A water-circulating system is installed in connection with a cooling tower on the roof. The water, which is circulated by a motor-driven triplex pump of 160 gallons capacity per minute, is used in the double-pipe ammonia condensers and in the water jackets of the engines. City water is used in the scrubbers.

How to Babbitt a Main Bearing

Plain Instructions for Removing the Old Metal, Preparing the Parts, Pouring the New Metal, and Reassembling

BY F. L. JOHNSON

It sometimes becomes necessary for an engineer to replace the antifriction metal in the main bearing of an engine. This process, by common use, is called babbitting, although the metal compound originated by Babbitt is seldom if ever used.

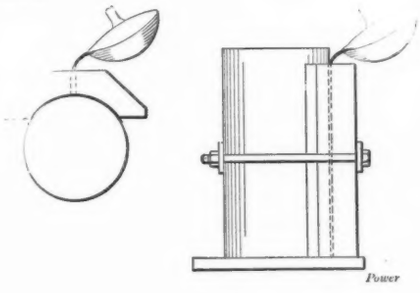


FIG. 1

In most cases the bearings of engines of 100 horsepower and upward are separable from the frame and are made in four pieces called shells, consisting of bottom, side or cheek and top pieces.

The first step in the process of rebabbitting is the removal of the old metal, which may be accomplished by melting over a forge fire if the shell is small; or by means of a wood or coke fire if the piece is too large to be handled easily at the forge; or by chipping. After the removal of the old metal the surfaces should be made absolutely clean, no trace of oil, scale or sand should be allowed to remain on the surfaces that are to be covered with the new metal.

Where there are conveniences for boring the bearing to fit the shaft a different course should be pursued from that where the bearing must be used without any machine work being done upon it. If the bearing is to be fitted by boring, a short mandrel or form, ¼ to ½ inch smaller than the shaft, is prepared, to which the sections of the shell may be clamped (Fig. 1), with insertions of strips of paper, wood or iron along the sides to prevent the escape of the metal and provide a depth of metal for boring.

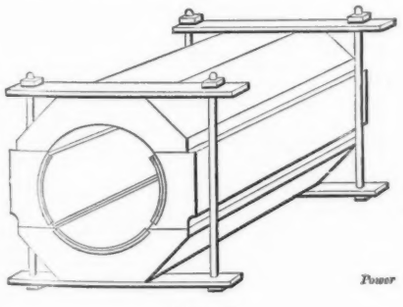


FIG. 2

The mandrel with the attached shell is stood on end on a flat surface, and the crack at the bottom stopped with sand, clay or putty. At the top a dam or reservoir should be made which will insure "head" enough to make the metal flow solid to the top of the shell and furnish material for the shrinkage which is usual.

Everything being in readiness for the pouring of the metal, this should be prepared. First, the ladle, which should be large enough to hold all the metal needed to fill the shell, should be clean. The metal should be melted slowly and if protected from the air by a layer of sawdust, fine charcoal or a film of rosin, it will pour much better than if the surface is allowed to oxidize and form a scum. It should be heated until the heat will brown the pine stick with which it should be stirred when melted.

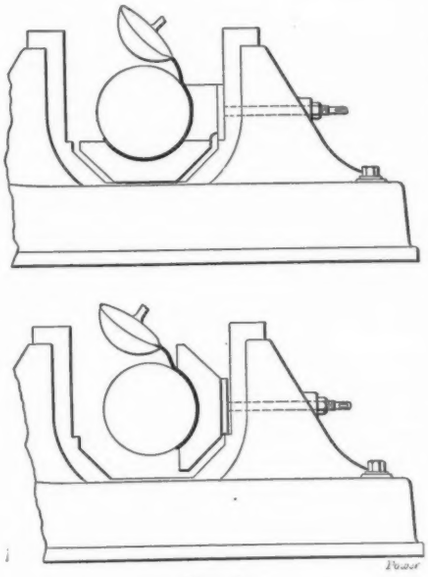


FIG. 3

The pouring should be rapid but without haste, the metal flowing fast enough to remain fluid at the top and sides until the smaller passage and thinnest parts are filled with solid metal free from "cold shuts."

If the molten metal is poured in a thin stream it will chill as it strikes the shell and mandrel and, instead of presenting a smooth surface, it will be streaked with cracks and mottled with overlapping sheets and empty spaces. A stream as large as a man's thumb will give good results, while one no larger than a lead pencil will usually result in an unsatisfactory job. Two or even three parts of the bearing may be clamped to the mandrel at the same time, if desired, but there is so little to be gained by this that the time saved on one job will not pay for the extra effort.

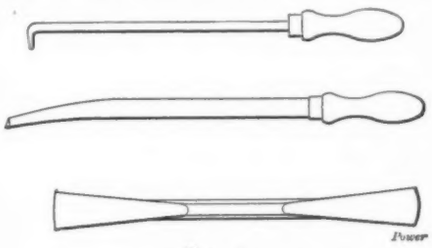


FIG. 4

After the pouring is complete, the metal should be thoroughly hammered all over the surface with a round-peened hammer weighing one and three-quarters to two pounds, compacting the metal and driving it solidly into contact with every part of the inclosing shell. After the hammering, the protruding ends should be cut off, all fins trimmed and the parts assembled for boring.

The parts of the shell should be assembled in the position that they will occupy in the engine frame and clamped rigidly together, preparatory to being taken to the lathe or boring mill to be finished, Fig. 2.

In the ordinary four-part bearing, consisting of bottom, top and two side shells, only the bottom and side pieces should be babbitted. As the top does not, should not and cannot touch the shaft while the engine is in operation, all time, effort and metal used on it are time, effort and metal wasted.

The assembled bearing may be taken to the machine and bored in exactly the same manner that an engine cylinder would be bored, making the diameter of the bearing one two-hundredth of the shaft diameter larger than the shaft. After the boring, the bottom piece should be scraped to fit the shaft and put in place, and the shaft lowered into position. The scraping of the side shells should follow. The side piece should

rest on the bottom piece and be tried for shaft fit while so resting, and when the scraping is complete the side or cheek piece should fit perfectly both shaft and bottom shell.

Where it is impossible or inconvenient to machine the parts of the bearing after the pouring of the metal, they must be babbitted on the shaft on which they are to be used. In this case the bottom shell is taken first, measurements are made which will determine the thickness of babbitt necessary to bring the shaft at the right hight when the bearing is reassembled, and strips of wood of the proper thickness are prepared to stop the opening between the shaft and the shell while the metal is being poured.

The shell may be blocked against the shaft and the metal poured from the side, as in Fig. 3, or it may be simply laid on top of the shaft and poured as in Fig. 1. If the second method is used, holes must be drilled for the inlet of the metal and the escape of the air. One ⅞-inch hole in the middle and one ¼-inch hole at each end will fill the bill completely. Whether the pouring is to be done from the top or the side the shaft should be smoothly and thoroughly covered with a sheet of strong manila paper about one sixty-fourth of an inch thick. In placing the bottom shell in position for pouring, care must be taken to get the planed

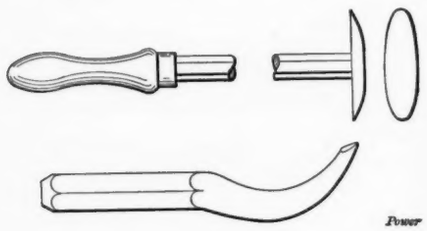


FIG. 5

surfaces upon which the side shells rest parallel with the axis of the shaft. If it is possible, the shell should be warmed before the metal is poured, as the smaller the temperature difference between the shell and the molten metal, the better the metal will run.

The paper covering serves a double purpose: It prevents the chilling of the metal by furnishing a nonconducting surface between the hot metal and the cold shaft, and by the larger radius of curvature counteracts the effects of the shrinkage which takes place when the shell cools, reducing the work of scraping to a very small amount.

In filling the cheek pieces they should rest on the bottom shell in the same relation to it that it will occupy when in use, and the thickness of the strips which are used to hold the shell in position should be such that the shaft will lie in the center of the frame jaws when the bearing is reassembled. Whether the shells have been filled by one method or by the other they must be fitted to the shaft in order to give satisfaction in operation. This fitting is best done by scraping, although good work has often been done with a half-round bastard file.

That part of the shaft that forms the bearing is covered with "marking," which may be almost any coloring matter that will mix with oil, such as red lead, prussian blue, vermilion lake, lampblack, or, in fact, any of the ready-made paints on the market. A little of the marking is taken on the ends of the fingers, on a rag, or on a bit of waste, and rubbed on the shaft, being finally distributed as thinly and as evenly as possible by rubbing with the palm of the hand.

The bottom shell is fitted first. It is laid on the shaft where the marking is spread and moved back and forth a few times, then taken off and turned over on a bench, or convenient box, the coloring showing plainly where the shell and shaft came in contact. Points where the color shows are called high spots, and the color is scraped or filed away. Each time the shell is taken from the shaft and scraped, a nearer approach to a fit between the shaft and shell will be expected. Scraping tools for this work are made in several forms, the commoner ones being of the curved and square-ended varieties (Figs. 3 and 4). These are readily made from wornout files.

In fitting the shells to the shaft it is not necessary that the fit be over the entire surface of the shell, nor is it necessary for the scraped surface to present the beautiful appearance of a planer cross rail, but the marking should show that the bearing touches the shaft over at least one-half of its surface. If the bearing does this it will run satisfactorily.

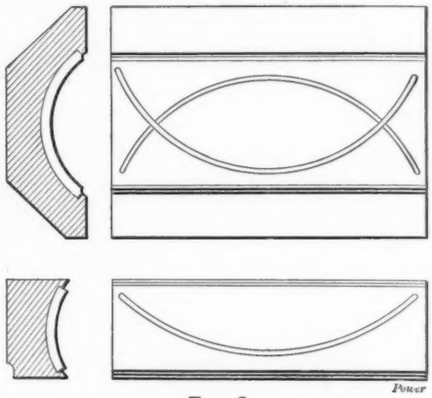


FIG. 6

It is claimed by some very successful engineers that scraping of bearings is a waste of time, and I have seen more than one engine main bearing brought to a working fit by a mixture of sand and water fed into the oil cavities, while the engine was turned over at about half speed. One erecting man, whose boast was that he never saw a hot box, always ran the main bearing in a bath of sapolio and water for two or three hours before putting on any oil.

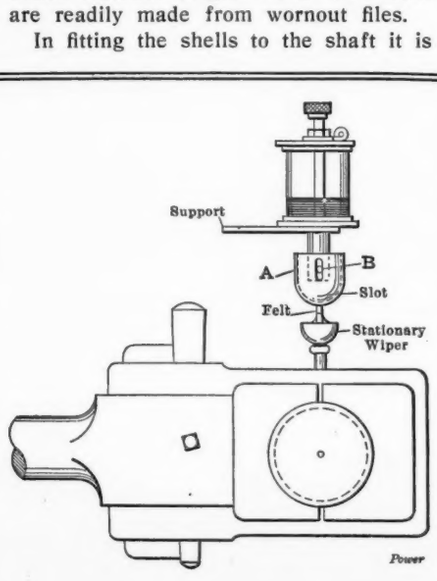
The bottom and side pieces should bear along the middle, but do not need to touch at the edges at first; contact there will come later.

If oil grooves are desired they may be made with a bent round-nosed chisel, or by means of a hook scraper, Fig. 5, which being drawn repeatedly over the same path ploughs a groove of a depth limited only by the patience of the operator. These grooves, which are erroneously supposed to assist in the distribution of oil, are usually started at or near the ends of the bearing and run in a curved line to the middle of the length of bearing, as in Fig. 6.

An Adjustable Wiper

A frequent trouble has been that due to the wiping device on the crank and crosshead passes, especially when the engine has been allowed to operate with considerable loose play, and more particularly when the wiper is closely adjusted to the cup on the crank. In the illustration will be seen an idea gotten up by an engineer, which absolutely prevents any trouble from the stationary wiper on the crank hitting too hard against the felt wiper of the oil cup.

The stationary wiper consists of a cup in which a cross piece is soldered, and to which a piece of felt is sewed. The oil



cup is fitted with a projecting piece of pipe in which pins *B*, on opposite sides, are fitted. The adjustable wiper *A* has a slot cut in the bottom, as shown, running longitudinally with the crank of the engine. The bottom is rounded and the sides fitted with slots, as shown at *B*, which allows the adjustable wiper to be moved up and down in case the stationary wiper touches as it goes past.

As the bottom of the adjustable wiper is rounded, there is no danger of knocking the oil-cup bracket out of position, because if the adjustable wiper is touched by the felt the stationary wiper is knocked to one side, allowing the wiper to pass easily under it, and wiping off the oil at the same time.

Symposium on the Effect of Superheated Steam on Cast Iron and Steel*

Cast Iron Fittings for Superheated Steam

By Prof. Ira N. Hollis

The failure of a number of large cast-iron fittings in use with superheated steam has rightly created a widespread suspicion of this material when exposed to high temperature. Yet on this subject there is very little information of a character to justify the wholesale substitution of steel castings for the ordinary heavy cast-iron fittings. The latter have been used with success for many years at all degrees of temperature below actual redness, and in many stations now in operation with moderate degrees of superheating (say 100 degrees Fahrenheit) cast iron has never given the slightest trouble beyond the ordinary wear and tear.

The doubt as to the reliability of cast iron has seemed to spring up with its use in long pipe lines to steam turbines where the temperature has ranged from 550 to 600 degrees. This would lead one to ask if the difficulty has not been in the design of the piping systems rather than in the character of the material. Has not the cast iron taken the brunt of a new service and has it not suffered in the estimation of the engineering public because the conditions of that service were not fully understood?

A vast amount of experiment and investigation would be required for the satisfactory reply to this question, and this brief paper is not intended as a reply, but rather as a record of some tests that may throw light on the subject. These tests were made for the Edison Illuminating Company of Boston for the purpose of determining the bursting strength under hydraulic pressure of some large fittings which were replaced with steel castings.

It may be well before giving the result of the tests to inquire what is actually known about cast iron subjected to high temperature; that is, known without the possibility of controversy:

a Fittings have developed cracks and small changes of shape after a few months of actual service.

b Fittings exposed separately to superheated steam at a temperature exceeding 500 degrees Fahrenheit have shown a permanent increase of some dimensions.

c The tensile tests of pieces cut from fittings that had failed in service indicate in some cases the possibility of permanent loss of strength.

The remainder of the evidence in the case may be classed as good guesswork based upon some preconceived theory as to the behavior of the constituent parts of cast iron in a rising temperature.

One of the curious and interesting qualities of cast iron is its permanent increase of dimensions under high temperature. This is paralleled by the permanent set of cast-iron test pieces when subject to very moderate tensile stresses. In both cases the cast iron apparently continues to grow at a decreasing rate, at least in some dimensions, when the high temperature or tensile stress is repeated.

How long this growth would continue is not known. Its probable limit is the flow of the material under the ultimate breaking stress. Cast iron may not be peculiar in this respect and all materials may change permanently their dimensions under moderate stress, the change growing with each imposition of the same stress. There is no doubt of this where the yield point of the material has been exceeded.

The cause of the persistent expansion under high temperature is still very hazy, but two possible agencies have been mentioned in a number of discussions:

a A chemical, or physical, change in the relation of the iron to the various foreign substances which fix it as cast iron.

b A molecular change due to the fact that cast iron has no well defined elastic limit or modulus of elasticity.

Both causes may be in operation at the same time, but the theory of chemical change has far less standing than that relating to the stresses produced by unequal expansion. While there is a temperature at which carbon changes its relation to the iron, superheated steam is probably well below that point except under very unusual conditions.

That cast iron loses strength when exposed to superheated steam at 600 degrees is not conclusively proved. The most that can be said is that test specimens taken out of cast-iron fittings after one year's or more exposure to a temperature of 550 to 600 degrees have shown a surprising irregularity of strength in the same casting. But there is nothing to prove that new cast-iron fittings have not a great lack of homogeneity. Irregularities exist in every casting owing to the inability of the metal to flow when cooling below a certain temperature. Furthermore, the strength of a test piece cast from a given heat can rarely be taken as that of any selected part of the fitting cast from the same heat. It is common experience to find variations of strain in castings as well as variations of texture. Were any large, irregular casting cut into small test pieces, the variations of strength would probably be found to be quite as great as that reported later on in this paper. The demonstration of the loss of strength after long service with superheated steam does not seem either complete or conclusive.

A very brief description of the essential features of the Edison station will help to make clear what follows. The new part of the station is arranged in a series of complete units each consisting of one vertical Curtis turbine and eight boilers set in pairs. The main steam line extends along the rear ends of the boilers just beneath the brickwork, four 8-inch vertical steam mains connecting each pair of boilers with the main line. Three of the vertical mains discharge through gate valve into tees, and the fourth, at the end of the line, through a gate valve into a bend.

The first turbine units were provided throughout with cast-iron fittings, which were ultimately replaced with steel fittings. No expansion or slip joints are used. The main steam line (something over 103 feet long) is anchored at the turbine end and is allowed to expand freely in a longitudinal or horizontal direction carrying the lower ends of the vertical mains with it. The steam pressure is 175 pounds, the superheating generally amounts to 150 degrees Fahrenheit, although it is not constant. The actual temperature of the steam varies from 500 to 580 degrees, so that the main line is changing in length from time to time, thus moving the lower ends of the vertical mains back and forth. A series of variable stresses is consequently introduced into all parts of the pipe system, probably affecting most seriously the tees. It is this aspect of the case, namely, the effect of varying stresses upon cast iron at high temperature, that must be studied before a sound verdict can be reached.

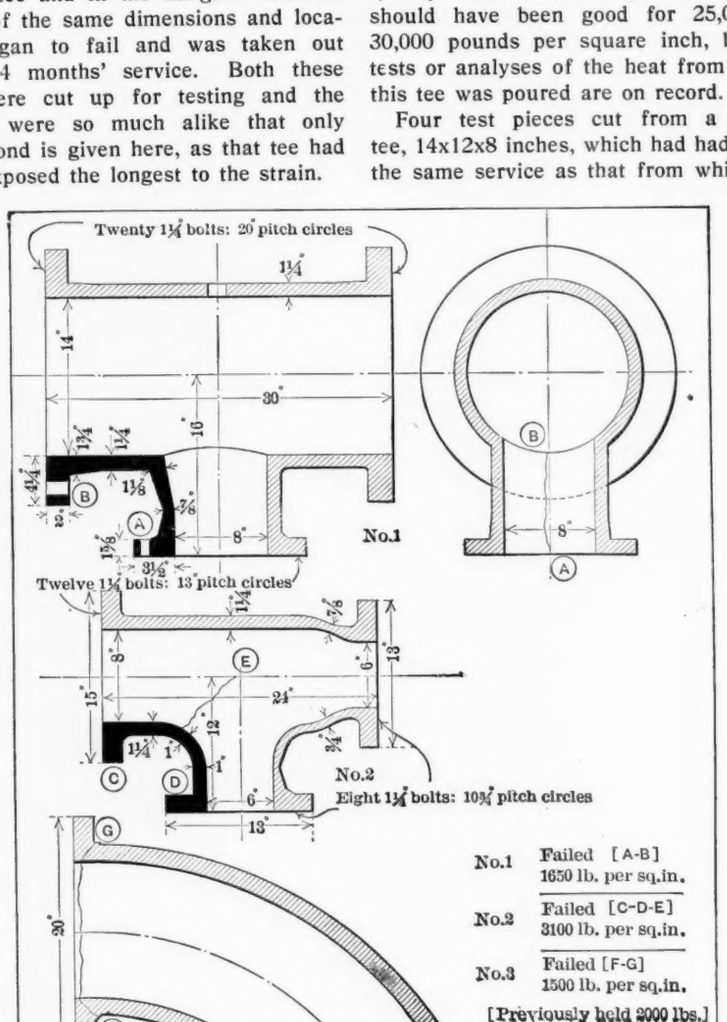
The castings in the South Boston station were first suspected of failure when

*Three papers presented before the American Society of Mechanical Engineers, at Boston, December 17.

nearly a year after the turbine plant had been in operation one of the 8x6x6-inch tees near the boiler showed signs of deterioration, cracks appearing near the junction of the offset with the body of the tee and in the flanges. Another fitting of the same dimensions and location began to fail and was taken out after 14 months' service. Both these tees were cut up for testing and the results were so much alike that only the second is given here, as that tee had been exposed the longest to the strain.

do not appear to indicate any great falling off in service. They are as near together as would commonly be found in cast iron from the same heat. The material was supposed to be a first-rate quality of air-furnace gun iron which should have been good for 25,000 to 30,000 pounds per square inch, but no tests or analyses of the heat from which this tee was poured are on record.

Four test pieces cut from a larger tee, 14x12x8 inches, which had had about the same service as that from which the


Twenty 1¼" bolts: 20" pitch circles
No.1
Twelve 1¼" bolts: 13" pitch circles
No.2
Eight 1¼" bolts: 10¾" pitch circles
No.1 Failed [A-B] 1650 lb. per sq.in.
No.2 Failed [C-D-E] 3100 lb. per sq.in.
No.3 Failed [F-G] 1500 lb. per sq.in.
[Previously held 2000 lbs.]
Twenty 1¼" bolts: 17¾" pitch circle
No.3
Sixteen 1¼" bolts: 17¾" pitch circle

SHOWING POINTS OF FAILURE UNDER HYDRAULIC PRESSURE OF THREE CAST-IRON FITTINGS USED WITH SUPERHEATED STEAM

A chemical analysis gave the following: Carbon, 3.47; manganese, 0.10; phosphorus, 0.366; sulphur, 0.062; silicon, 1.41. The tensile strength of six pieces taken from different parts of the tee was found to be, 12,646, 14,295, 26,080, 27,270, 27,440, 28,280 pounds per square inch. There thus appears to have been considerable variation of strength in the tee unless the first two results are errors due to some faults in testing. Not considering them, the four other pieces foregoing test pieces were cut, gave a tensile strength of 23,130, 23,480, 23,875, 24,170 pounds per square inch. Here again there was absolutely no proof that the material had deteriorated.

Three test pieces were taken, for comparison, from a large manifold which had been seven years in service with saturated steam, and the tensile strength was found to be 16,413, 16,550, 17,000 pounds per square inch. The nature of the cast iron was not known positively, but it was bought as air-furnace gun iron.

It was fully recognized in the first of the foregoing tests that, while the material might not have suffered in service, nevertheless parts of the casting might have been weakened by the expansion stresses. For the purpose of testing this, two tees were removed from the line and broken by internal hydraulic pressure, thus affording a definite idea of the strength of the castings as a whole. A third casting, an ell not previously in use, was added for comparison. The three fittings are shown in the figure in which the measured dimensions and the location of the fractures are given.

The material was the same as that used for all the fittings of the turbine unit, air-furnace gun iron, and the chemical constituents were probably about the same. The two tees had been exposed to superheated steam of 578 degrees Fahrenheit and less for 15 months, or longer, and when removed had given no indications of weakness. A careful examination disclosed no appreciable distortion except in the faces of the flanges which were no longer plane surfaces. There were several high spots that could not have existed when the flanges were faced off.

No. 1 was a 14-inch tee with an 8-inch offset. The openings were closed by heavy cast-iron plates fitted to the flanges and bolted. The pressure was produced by a steam-driven outside-packed plunger pump, and was measured by means of a small conical safety valve, 1/10 square inch in area, and directly loaded by dead weight applied as the pressure increased. The indications of the small valve were constantly compared with a hydraulic gage previously tested and calibrated at the Crosby manufactory. The fitting broke as shown at an internal pressure of 1650 pounds per square inch. The plates covering the openings did not reinforce the tee to any great extent as the bolts were smaller than the holes and the joints around the flanges were leaking appreciably when the fracture occurred.

No. 2 fitting was an 8x6-inch tee. It was broken in precisely the same manner as No. 1 and gave way at an internal pressure of 3100 pounds per square inch.

No. 3 fitting was a 12-inch ell. Its two openings were closed with cast-iron plates and it was burst in the same way as the others. The joints practically gave out at a pressure of 2000 pounds per square inch although the pressure was kept on for some minutes. For the second attempt to run the pressure up, the bolts were set up with a very heavy wrench, which undoubtedly put a bending moment on the flange. The fitting finally parted all around the root of the flange at a pressure of 1500 pounds per square inch.

Four test pieces were cut from the larger tee and broken under tensile stress. Their dimensions were almost exactly ¾ inch in diameter by 6 inches between fillets. Two of them were broken cold and gave a tensile strength of 22,150 pounds per square inch, and two were broken at a temperature of 590 degrees at 20,050 pounds per square inch. The temperature of the latter was maintained by means of a cylinder-oil bath, the oil being placed in a large tube surrounding the test piece and kept hot by a gas flame.

No information could be obtained as to the original strength and chemical composition of the iron and it would be impossible to prove that it had changed either in strength or in composition. There is ground, however, for believing that it had changed, as the smaller tee mentioned gave as high as 28,000 pounds tensile strength in one specimen.

A comparison of the larger tee with those tested and reported in the *Valve World* for November, 1907, throws an interesting light on the subject. The formula there published as derived from a very large number of tests of cast-iron and ferro-steel fittings may be taken as a basis for calculating what should have been the bursting pressure of the 14-inch tee. This formula is

$$B = \frac{T}{D} \times S,$$

where

D = Inside diameter of the tee,
T = Thickness,
S = Tensile strength of the material multiplied by 60 per cent.,
B = Bursting pressure in pounds per square inch.

Taking the tensile strength of the cast iron when hot at 20,000 pounds per square inch, the diameter of the tee at 14 inches and the thickness at 1¼ inches, the value of B is 1070 pounds per square inch, whereas the tee actually burst at 1650 pounds. This did not seem to indicate weakness or deterioration.

It is interesting to inquire here what stress existed in the tee during its service. That due to the steam pressure was small when compared with the actual bursting pressure, but that due to expansion may have been serious in its effect. The first tee in the main steam line was located at 4 feet 8⅝ inches from the anchorage, the second 37 feet 8⅝ inches, the third 70 feet 8⅝ inches, and there was no expansion joint to ease off the pressure on the vertical mains. Taking the third tee for purposes of illustration, certain suppositions can safely be made:

a The lower flange of the vertical pipe moves in a horizontal plane as the main pipe expands and therefore the lowest point of the axis of the pipe moves parallel to itself.

b The upper end of the vertical pipe is practically fixed. The expansion of the main steam pipe thus puts an S bend in the vertical pipes and introduces large bending movements into both ends of it and into the tee. The actual length of the pipe between its lowest flange and the upper end is 26 feet, but the length between the upper surface of the tee and the upper end of the pipe is about 28 feet.

The linear expansion of the main steam line is about 3 inches when heated to 578 degrees Fahrenheit. The effect of this is supposed to be halved by cutting the pipe short and springing the flanges into place when making the joints. There is thus an initial deflection in the vertical pipe. This is overcome as the pipe is heated and carried as much farther on the other side.

The value of the deflection in the lower end of the pipe is then taken at 1.5 inches. The formula for the maximum deflection of a beam fixed at one end and moved parallel to itself at the other end is

$$Y = \frac{W l^3}{12 E I}$$

where

W = Load in pounds or push of the horizontal pipe,
l = Length in inches,
E = Modulus of elasticity,
I = Moment of inertia of the pipe.

The inside diameter of the pipe is 8 inches, and its thickness is 0.322 inch, giving the value of $I = 72.5$; E is taken at 30,000,000.

The equation for the deflection is then

$$1.5 = \frac{312^3 W}{12.725 \times 30{,}000{,}000},$$

and W is found to be 1288 pounds. Thus if the expansion of the pipe is exactly split by cutting the main line short, the push on the lower end of the vertical mains is 1288 pounds. The point of contrary flexure in the S bend of the pipe is about 179 inches above the junction of the offset of the tee with its main body. The bending moment in the offset of the tee is therefore 1288 × 179 inch-pounds and the stress set up is

$$S = \frac{Mc}{I} = \frac{1288 \times 179 \times 5}{290} = 3975 \text{ pounds.}$$

While this calculation is not entirely reliable on account of the uncertainty as to the elastic curve of the vertical pipe, nevertheless it is a fair indication of the stress to be expected in this tee when the temperature of the pipe reaches 578 degrees. Furthermore, it is made under the supposition that the expansion of the pipe was lessened by an initial pull and that all the joints came exactly fair before setting up the bolts. It is easy to imagine how serious the stresses might have become under actual conditions of inaccurate fitting. The one element of splitting the expansion is very uncertain. The foregoing stress might easily have been doubled, resulting in pulling the tee quite out of shape and in setting up internal strains certain to weaken the material in places.

Under such conditions, it was, and would generally be, wise to replace the cast-iron tees with cast steel which would yield more readily to expansion and which would be safer at much higher tensile stresses. The reason for the substitution ought not to be lost sight of in such a case, if cast iron is to be judged fairly. It is made because it is cheaper on the whole to replace the cast iron with steel rather than to put in expansion or slip joints. Perhaps the steel casting is also much easier to take care of than any form of expansion joint. The unreliability of cast iron in such a service has nothing to do with the case; it is merely that the design usually adopted for steam piping does not quite fit cast iron.

The Effect of Superheated Steam on the Strength of Cast Iron, Gun Iron and Steel,

By Edward F. Miller

The object of this paper is to describe some experiments made to determine the effect of superheated steam on cast iron, gun iron and steel. From each piece to be tested two tension specimens were made, one to be subjected to the action of superheated steam, and one to be used in obtaining the original strength of the piece.

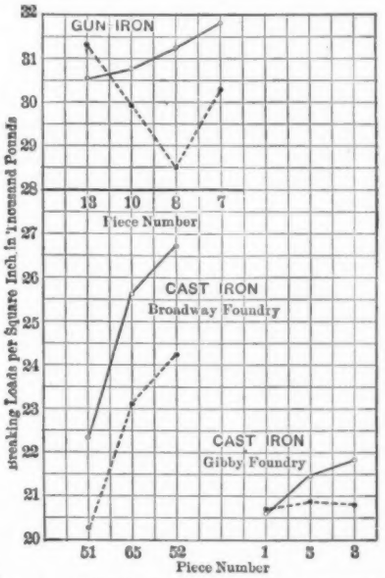


Fig. 1. Breaking Load of Gun-iron and Cast-iron Test Pieces

All of the specimens were made with screwed ends in accordance with the specification prepared by the American Society for Testing Materials. The tension tests were made on a 100,000-pound Olsen testing machine, the specimens being screwed into spherical holders at-

tached to the heads of the testing machine, thus insuring a straight tension pull without any bending.

The specimens to be subjected to superheat were placed on a wire grating suspended at the center of a 12-inch iron pipe about 3 feet long, supported horizontally on brackets. The ends were closed by blank flanges. Steam was supplied by a small pipe, a flow at low velocity being maintained at all times. The under side of the pipe was heated by Bunsen gas burners. Thermometers, in wells reaching down to the grating on which the specimens were placed, gave the temperature of the steam, the pressure being read from a steam gage on the supply pipe.

For the tests plotted in Fig. 1, the average gage pressure in the superheating pipe was 93 pounds and the average temperature 660 degrees Fahrenheit. The gas flame was extinguished at 5 p.m., and lighted again at 7 a.m. The temperature reached 660 degrees Fahrenheit by 11 a.m. and by 5 p.m. would be as high as 700 or 720 degrees Fahrenheit. Steam was kept in the superheater during the night. The total time these specimens were exposed to superheated steam was 260 hours, and the exposure to saturated steam was 460 hours. A chemical analysis of the iron tested is given in Table 1.

TABLE 1. CHEMICAL ANALYSIS OF CAST-IRON SPECIMENS, FIG. 1.

	Phosphorus.	Total Carbon.	Graphitic Carbon.	Manganese.	Silicon.	Sulphur.
Cast iron, Gibby foundry		3.51	3.02	0.37	1.88	0.05
Gun iron, Hunt Spiller	0.41	3.25	2.60	0.24	0.54	0.09
Cast iron, Broadway foundry		3.34	2.84	0.38	2.26	0.09

For the tests plotted in Fig. 2 the average gage pressure was 82 pounds and the average amount of superheat about 390 degrees Fahrenheit. These specimens were subjected to superheated steam for 520 hours, and to saturated steam for 920 hours. A chemical analysis of three of the semisteel specimens is given in Table 2. This semisteel was made by adding 200 pounds of steel to 1500 pounds of cast iron. The analysis of the gun iron showed, total carbon, 3.37; graphite, 2.44; manganese, 0.34; sulphur, 0.11; silicon, 1.65.

The composition of two of the rolled-steel pieces, No. 26 and No. 27, was as follows:

	Phosphorus.	Total Carbon.	Manganese.	Sulphur.	Silicon.
No. 26	0.85	....	0.73	0.026	0.026
No. 27	0.116	....	0.90	0.057	0.031

In Fig. 1 and Fig. 2 the open circles represent the ultimate strength per square inch of the original specimen while a full circle on the same ordinate gives the strength per square inch of the comparison specimen which had been subjected to the action of superheated steam. By figuring the per cent. loss in strength in each specimen and then taking the average of these per cents., it appears that the cast iron from the Broadway foundry (Fig. 1) lost 9.5 per cent.; that of the Gibby foundry 2.4 per cent. The cast iron of Fig. 2 came from the Waltham foundry; here there is apparently a gain in strength of 1.8 per cent. Figs. 1 and 2 show that gun iron loses strength, Fig. 1 showing a loss of about 3.5 per cent., and Fig. 2 about 2.1 per cent.

TABLE 2. CHEMICAL ANALYSIS OF SEMISTEEL SPECIMENS, FIG. 2.

Phosphorus.	Total Carbon.	Graphite.	Manganese.	Sulphur.	Silicon.
....	....	2.64	....	0.11	....
0.24	3.48	2.39	0.35	0.11	1.91
0.61	3.22	2.83	0.44	0.49	2.62

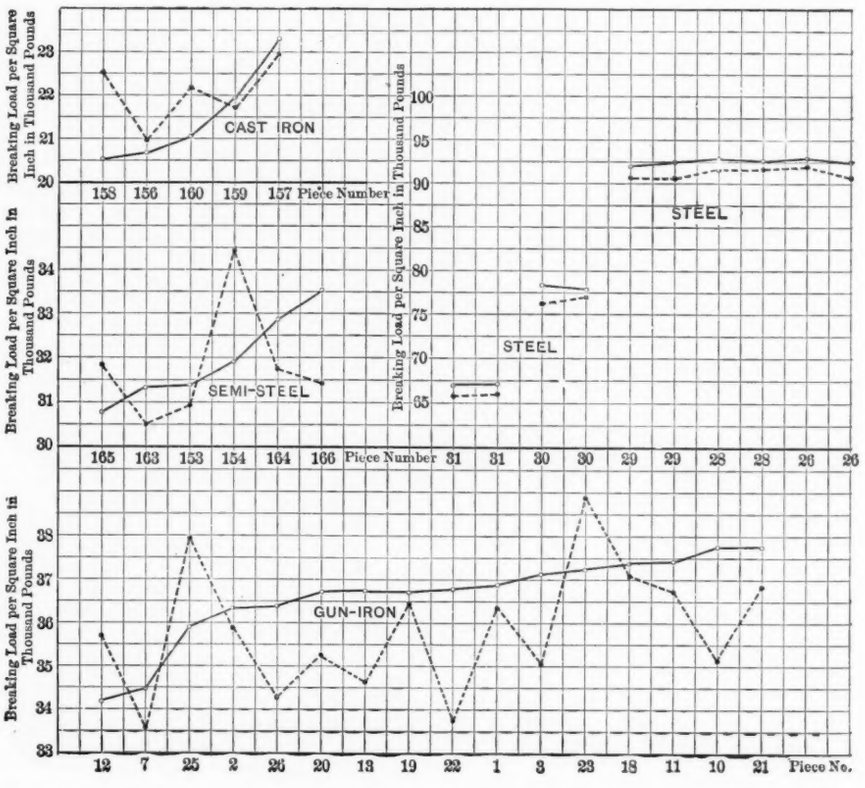

Breaking Load per Square Inch in Thousand Pounds
CAST IRON
158 156 160 159 157 Piece Number
STEEL
SEMI-STEEL
STEEL
165 163 153 154 164 166 Piece Number 31 31 30 30 29 29 28 28 26 26
GUN-IRON
12 7 25 2 26 20 13 19 22 1 3 23 18 11 10 21 Piece No.

FIG. 2. BREAKING LOAD OF GUN-IRON, SEMISTEEL AND CAST-IRON TEST PIECES

The tests on semisteel show an average reduction of strength due to exposure to the steam, of about 0.4 per cent., four out of six pieces showing quite a reduction. If piece No. 154 is not considered, the percentage reduction of strength would be much greater.

Four grades of steel were tested: two pieces from a bar of 65,000 to 70,000 pounds tensile strength, two from a bar of 75,000 to 80,000 pounds tensile strength, two each from three bars of about 90,000 pounds tensile strength and two from a bar of over 100,000 pounds tensile strength. The 65,000- to 70,000-pound steel showed a loss of 1.8 per cent., due to exposure to the steam, the 75,000- to 80,000-pound steel a loss of 1.9 per cent., the 90,000-pound steel a loss of 1.5 per cent., and the 100,000-pound a loss of 24 per cent.

While one is not justified in drawing many conclusions from the results of as few tests as are quoted here, still it is evident from Figs. 1 and 2 that the metals tested have suffered a loss in strength due to their exposure to the steam. A paper bearing on this subject, "Materials for the Control of Superheated Steam," by M. W. Kellogg, appeared in the 1907 *Transactions* of the Society. In the *Valve World,* March, 1908, are given the results of tests on cast iron taken from the body of a 14-inch valve which had been in use for four years on a main carrying steam at 200 pounds pressure and superheated to a temperature of 590 degrees Fahrenheit. A number of test bars cut from the body of the valve showed a loss of strength of 41 per cent. when compared with the strength of the original metal as determined from coupons tested at the time the valve was made.

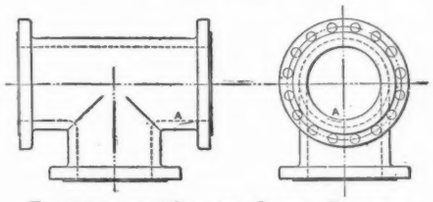
Fig. 1 in this paper formed part of the thesis of H. A. Terrill, M. I. T., '07, and Fig. 2 part of the thesis of F. M. Heidelberg, M. I. T., '09.

Cast-Iron Valves and Fittings for Superheated Steam

By Arthur S. Mann

There have been many failures of cast-iron valves and fittings in piping systems carrying steam of high pressure and high superheat. The ordinary extra-heavy flanged cast-iron fittings which are listed in many manufacturers' catalogs as suitable for 200 pounds pressure and which have to meet a close price competition, have successfully carried a pressure perhaps as high as 150 pounds or more. No doubt the fittings and valves can support a steady pressure of 200 pounds without bursting, but there have been many failures when carrying superheated steam of lower pressure.

These fittings are not too well suited for permanent work of even 150 pounds pressure, and many engineers in control of such matters in stations of a representative type prefer to design their own parts rather than to trust the usual run of commercial extra-heavy fittings.



Failure of 10-inch Steel Fitting

Probably on account of the advertised ability to support a high steady pressure these extra-heavy fittings and valves have been used in a number of instances for superheated work. After a short time, six months or even less perhaps, cracks make their appearance; valves leak, seats become loose, castings grow in length and surface cracks become so large in size and in number that the casting is removed from the line.

A few repetitions of this experience seem to justify the conclusion that cast iron is not fit material for high-temperature steam. The natural substitute is steel, which is used with fair, even complete, success in many cases.

It is known that cast iron will grow with repeated heatings and coolings, often observed in the ordinary straight grate bar. When the bar is first heated it expands and cools as it contracts; but if the temperature has been high, the bar will increase in length. With a second heating, a further increase takes place, followed by many others. As a consequence the long, single, straight, flat grate warps and proves the wisdom of McClave's rule, "Keep your long lines of metal away from the fire."

This subject of growth has been treated very completely by Outerbridge in his excellent paper published in the *Journal* of the Franklin Institute for February, 1904. Mr. Outerbridge heated his samples to redness or above, temperatures greatly exceeding that to which a steam-pipe fitting is subjected.

A rough experiment on this line was tried by the writer with two samples, one of an ordinary cast iron and a second of a high-grade cast iron, which has proved itself capable of carrying superheated steam and of which a detailed analysis is given a little further on in this paper. The two samples were each 6 inches long and 1 inch in diameter. They were placed in a banked fire over night, reaching a dull red heat, and were allowed to cool in the air. A slight growth as measured by micrometer was found in each piece.

This treatment was followed for two or three nights and the growths were measured. There was an increase in the length of each of the samples, the high-grade iron having increased in length slightly more than did the ordinary iron. The experiment so far as it went tended to show that the growth of cast iron does not necessarily unfit it for the usual degree of superheat in power-house work.

Many grades of brass will crumble when heated in a forge to a barely visible red, and are quite unfitted to support any stress at such a temperature. But this characteristic in no way unfits very ordinary cast brass for saturated steam work, and one should not hesitate to use a valve of cast brass up to 3 inches in diameter for 150 pounds saturated steam pressure. Three inches is not usually exceeded because valves of large brass bodies are expensive.

Articles have appeared in various publications showing the disability of cast iron, tensile tests being made before and after the use of fittings of ordinary iron. Cases of bronze seats dropping from valves were cited and it was not difficult to prove that something better than ordinary cast iron was needed for steam of 180 pounds pressure and 250 degrees superheat. These failures came from two causes. In the first place the iron itself was not of sufficiently good quality; and, secondly, the parts were not thick enough. The static stress probably did not exceed 1000 pounds in the body; but static stress is not the important load which fittings have to support.

Stresses from expansion and contraction within and without the casting and stresses from pulling up joints no doubt greatly exceed the static load even in pipe very carefully erected. The troubles are aggravated by the action of the steam itself, but it is yet to be proved that the steam or its high temperature will of itself start cracks in a properly designed fitting.

The ordinary commercial extra-heavy flanged tee, 8 inches inside diameter, has a body $\frac{7}{8}$ inch and flanges $1\frac{5}{8}$ inch thick. It is made of common iron, having a tensile strength of about 18,000 pounds. Such a fitting will fail with superheated steam at 175 pounds pressure and 200 degrees superheat. Within a year the inner surfaces will have a network of cracks, some of which will increase in depth till they extend through the body. The flanges will crack outward from the bolt holes and the fitting will become not only leaky but dangerous as well. The writer has observed just such castings, an analysis of some of them being given later in this paper. Similar effects have been experienced by a great many steam users. The fittings are inherently weak to begin with, so that the failures do not prove that a heavier fitting of better iron is unsuited for superheated-steam work.

Within the experience of the writer steel fittings have failed with superheated steam. Out of 25 steel gate valves, 6, 8 and 10 inches in diameter, not more than four were fairly tight after one year's service, the bodies themselves yielding enough to leak badly. Some defects in the castings developed, allowing steam to pass straight through the walls, when they left the foundry. Some of these defects were such that the fittings and valves could not be repaired. In some cases seats were scraped in once or twice and holes were plugged up or patched, but the material would not have been satisfactory without this working over. Yet all these castings were heavy, materially thicker than the commercially extra-heavy cast-iron product, and had passed a rigid inspection.

The illustration shows a 10-inch steel fitting, the irregular line at *A* showing a defect developed after use. The line does not pass clear through the casting, and no doubt the piece was amply strong to resist rupture even after the fault developed. Some of these fissures went 3 inches back and were 5 inches broad. Such a large opening in a shell is objectionable for there are blowholes enough adjacent to it to pass steam in large quantities. Some fittings of this kind were removed from the line entirely, while others were plugged or patched.

No doubt a thoroughly sound steel casting is able to withstand highly superheated steam. There are several connected to the system under discussion. So far as it has been possible to observe, superheated steam does not of itself initiate defects and it is not supposed that the sound metal undergoes a change, either chemically or structurally. But if there is an initial defect, superheated steam is much more active in bringing out the objectionable features of that defect. It may well be that the foreign material within the body, and not a part of the actual metal, suffers through change of some sort. This material does not add to the strength of a casting, but it may serve to stop up holes if allowed to lie undisturbed.

It would appear that some material better than the ordinary steel casting was desirable for high-temperature work. Such a material is found in gun iron. Gun iron is nothing more than a high-grade cast iron, which any first-class iron foundry can produce. In the days of the smooth-bore cannon, a few foundries discovered that it was possible to produce an iron having a tensile strength of 30,000 pounds or more. The Government specified it for its guns and it was called gun iron. Probably a tensile strength of 30,000 pounds is not needed in steam fittings, but iron of that quality is well adapted for 180 pounds steam with 300 degrees superheat.

From such observations as have been thus far possible it appears that certain elements in the iron are liable to cause trouble when present in excess, and perhaps the worst of these is silicon. It is at present going too far to say that every high-silicon iron will fail and that every low-silicon iron will prove successful, but there is much evidence pointing toward the correctness of such a surmise. In any event iron of low silicon, low phosphorus and low carbon—in other words, gun iron—has proved successful.

The following analysis shows the character of a casting which failed at 250 degrees superheat:

Silicon	2.40 per cent.
Sulphur	0.067 per cent.
Phosphorus	0.94 per cent.
Manganese	0.52 per cent.
Total carbon	3.19 per cent.
Combined carbon	0.25 per cent.

A second failure developed in this iron:

Silicon	1.98 per cent.
Sulphur	0.068 per cent.
Phosphorus	0.65 per cent.
Manganese	0.42 per cent.
Total carbon	3.31 per cent.
Combined carbon	0.24 per cent.

In each of these cases a sample was taken by drilling a hole straight into the body after the part had been in service a year or more and was in bad condition.

The following analysis is of an iron that has been successful in every respect for four years under 300 degrees superheat:

Silicon	1.72 per cent.
Sulphur	0.085 per cent.
Phosphorus	0.89 per cent.
Manganese	0.48 per cent.
Total carbon	2.45 per cent.
Combined carbon	0.17 per cent.

The latter sample is from an 8-inch valve and it is tight today, no repairs whatever having been made upon the valve during the four years though the bonnet was taken off once to permit internal examination. The outer surface of the valve was covered with 85 per cent. magnesia insulation, 4½ inches thick. The inner surface appeared sound; a microscope revealed no cracks or other defects. The unfinished surfaces were struck several sharp blows with a ball-peen hammer, a hand chisel was driven straight at the surface and some thick chips were cut off from the rough portion. If the metal had suffered to such an extent as cast iron is supposed to suffer, some of the defects would have made themselves manifest. After these treatments the valve was reassembled and has continued to perform its work properly.

Foundrymen are not afraid to attempt to produce this iron. No difficulty whatever was encountered in securing bids for valves made of the following mixture:

Silicon	1.40 to 1.60 per cent.
Phosphorus	0.20 to 0.40 per cent.
Sulphur	0.06 to 0.09 per cent.
Manganese	0.45 to 0.75 per cent.
Total carbon	3.00 to 3.25 per cent.

It will be noted that the percentages of silicon and phosphorus are low.

There is, of course, a decided advantage in depending upon chemical analysis for determining the suitability of fittings. A hole can be drilled at any time in the actual fitting and a few grams of sample secured. Very few of us are willing to destroy a fitting to obtain a test bar, and test coupons cast in the foundry may or may not represent the actual piece.

Superheated steam was in commercial use in Europe before the practice had gained its present hold here. England and Germany were using superheated steam 20 or more years ago. The writer has not discussed this subject with engineers from abroad, but wishes to quote briefly those who have.

E. D. Dickenson, of Schenectady, on a recent trip abroad asked a great many manufacturers whether they used steel for their superheated work and received a negative reply in each instance. When the manufacturer was questioned in regard to his iron mixture he shrugged his shoulders and replied that he made his iron fit his needs, be it gas-engine cylinder or steam pipe.

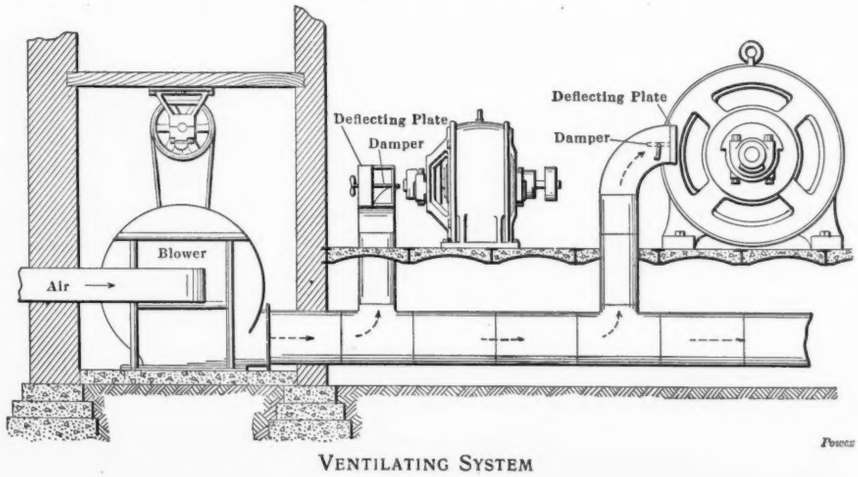
John Primrose, in POWER AND THE ENGINEER, for June 8, 1909, states that he discussed the matter with English and German engineers. In one instance a well known German engineer, who had used superheat for 25 years, was surprised that he had not learned of the effect of superheated steam upon cast iron. The engineer promised to investigate the matter in Germany, but he could find nothing to bear out the contention, and could find no one who believed that such a thing was possible.

It is not the author's intention to state that steel of good quality will not do for superheated work. Some manufacturers are putting out fittings of open-hearth steel which are doubtless good; but any foundry can make gun iron if it will, and delay and uncertainty will be decreased by its use.

Ventilation for the Engine Room

It is not often that a plant manager gives the comfort of his engineer any concern, but in one instance noted recently, the device illustrated herewith shows that all plant managers are not alike. In this case an air duct was extended up on the outside of the engine room above the roof so that cool, pure air could be obtained. This air duct was carried down to a blower located in one corner of the engine room, as shown, the air duct being 30 inches square.

From the blower to each machine an air pipe was laid, a branch pipe coming up through the floor at each machine, blowing the cold air onto the commutator, which in the case of the alternators was sucked in around the field winding, thus keeping the machine cool. This also provided the engine room with cool air, and added to the comfort of the operators. The sketch shows the general arrangement of the ventilating system, the outlet of each branch being fitted with a damper and a deflecting plate, as shown. In the case of the larger machine, the air duct came into the pit in which the generator is set in a direct line.



VENTILATING SYSTEM

ELECTRICAL DEPARTMENT

Especially conducted to be of Interest and Service to the men in charge of the Electrical Equipment

Electric Elevators

BY WILLIAM BAXTER, JR.

The brake of the machine shown in Fig. 75 is constructed as shown in Fig. 80. The brake wheel *A* is clamped between two shoes *B'* mounted on the ends of arms *C* that are pivoted to the frame *B* at the points *C'*. The shoes are held by the pins *C''*. The springs *F F* act to force the brake shoes against the wheel *A*, and the magnet coil *E*, when energized, draws in the plungers *D' D'* and pulls the brake off. The screws *H* adjust the movement of the brake shoes, and the screws *H'* act to hold the lower ends of the shoes so that they will not drag against the brake wheel. These screws force up against the shoes small springs until the tension is just sufficient to balance the weight.

The rope rigging used by the Otis Company with mechanical-control elevators is arranged according to the running rope system, as shown diagrammatically in Fig. 81. A hand wheel *A* is used in the car, and on the outer end of the shaft is mounted a sprocket wheel *B* over which runs a chain *B'*; to the ends of this chain the operating ropes *C* and *C'* are attached. These ropes run down under the sheaves *D D'* carried by the central sheave *L*, over which runs a rope *J J* that passes around the operating sheave *A* mounted on the end of the stop motion shown in Fig. 77. The ropes *C* and *C'* run up to the top of the elevator well over the sheaves *E* and *E'* and thence down to the top of the elevator car where they are made fast at *F F'*. By means of the weight *W* the proper tension is maintained on the ropes. It is evident that the rotation of the hand wheel *A* will raise one and depress the other sheave *D* and thus rotate the sheave *L* and thereby turn the operating sheave *A* on the stop motion of the machine.

The construction of the controller used with the machine shown in Fig. 75 is illustrated in Fig. 82, which presents a front and a back view. On the front of the panel can be seen at the top a potential switch, which is of substantially the same construction as the one already explained in connection with the earlier type of Otis elevator. At the bottom of the board is a magnet switch that acts to cut out the starting resistance; this is called the accelerating magnet. Its construction and operation will be better understood from Fig. 83. There is one long magnetizing coil that acts to draw down four separate switch levers. These levers are set so that each one rests slightly further away from the end of the magnet core than the one to the right of it. Because of this way of setting the switch levers they are not all pulled to the closed position at the same time; the nearest one is closed first, then the one next to it is closed, then the third one and finally the fourth one. To accomplish this successive closing of the switches it is necessary that the strength of the magnet shall gradually increase, and the way in which this is accomplished will be shown in explaining the wiring diagram.

The way the switch levers are set so that each succeeding one is further away from the magnet core than the preceding one is shown in the side view in Fig. 83. In this drawing it will be seen that the stand *A* has an extension *A'* against which rests the end of an adjusting screw *B'* that is carried by the switch lever *B*; each lever has a screw like this, and by adjusting these screws the four levers can be set so that each one is held a little further away from the core *C* than its left-hand neighbor, hence, the pull of the magnet must gradually increase so as to pull up the levers one after the other. How this is accomplished, and how the reversing switches and other parts of the controlling apparatus act can

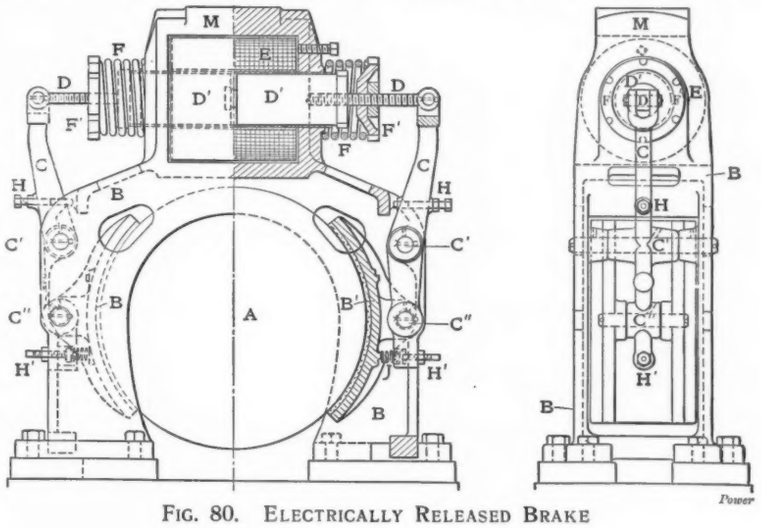


FIG. 80. ELECTRICALLY RELEASED BRAKE

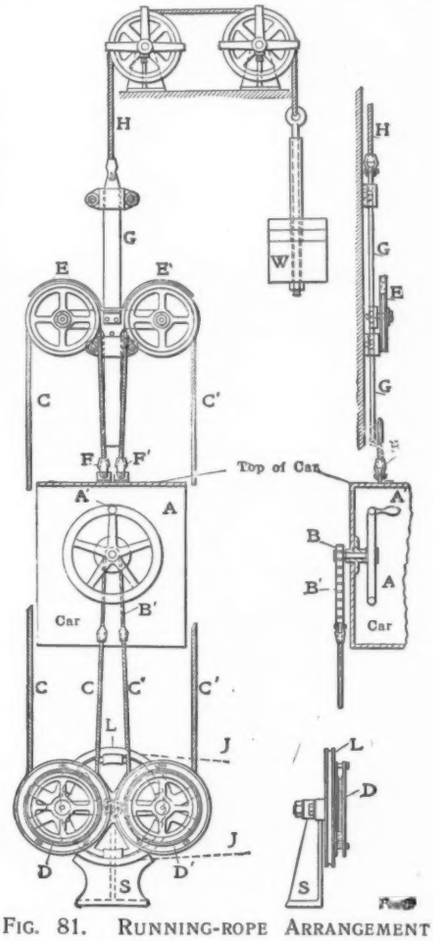


FIG. 81. RUNNING-ROPE ARRANGEMENT

be made perfectly clear by the aid of the wiring diagram, Fig. 85.

In the wiring diagram the potential switch is shown at the upper right side, and if we start from the point *A*, through the fuse *O+*, the circuit will be through the safety switch in the car, through the limit switch in the elevator hatchway, to the wire *+P* to and through the magnet coil of the potential switch to the wire *—P;* thence through the slack cable stop to the wire *O—* and to the opposite side of the line at point *A'*. This circuit remains closed as long as the potential switch remains closed, unless it is broken by the opening of one of the limit switches, by the slack cable switch or by the safety switch in the car. This latter switch is provided so that if for any reason the operator loses control of the elevator he can stop the car by opening this switch. The reversing switch is shown on the left side of the diagram, and the switch levers operated by the cams *III* and *IV* are the reversing switch proper, while the levers operated by the cam *I* are the main line switch and those operated by the cam *II* close the circuit through the brake magnet and through the accelerating magnet.

In starting, the cams *III* and *IV* close their switches first and connect the armature and field winding of the motor for the proper direction of rotation before the current is on. The cam *I* closes its switches next and thus completes the circuit, and the cam *II* immediately closes its switches, and the brake is raised and the motor begins to turn. The accelerating magnet is connected in parallel with the armature and a small portion of the starting resistance, as will be found by following the circuit from the switch lever 4 to the point *J*, thence up through the switch 5 and the wire *b* through the armature to the wire *c;* through the switch 7 to the wire *d*, to the upper end of the starting resistance. As a result of this connection, when the armature begins to rotate the current flowing through the accelerating magnet is weak, but as the armature speeds up the current will increase, because the counter electromotive force of the armature will increase. Thus the faster the armature rotates, the stronger the accelerating magnet will become. When the armature reaches, say one-quarter of the full speed, the magnet will be strong enough to pull the nearest one of the switch levers, No. 1 on the right. When the speed increases, the second switch will be closed, and at the increase in speed produced thereby, the third switch will be closed; the last switch being closed a little before full speed is reached.

The current will flow through all the wires in the direction indicated by the arrow heads if the reversing switch cams are rotated clockwise, so as to close the reversing switches 5 and 7. When the cams *I* and *II* move far enough they permit both the switches they control to close. When the elevator is stopped, the cam *II* opens its switches first, then follow the cams *I, III* and *IV* in the order named. From this it will be seen that the reversing switch does not open until after the line is opened by the opening of switches opposite cam *I*.

The diagram Fig. 85 does not show clearly that the coil of the accelerating magnet is connected in parallel with the armature, and that it shunts the latter and a portion of the starting resistance. The actual connections are as shown in the simple diagram, Fig. 84, in which *A* represents the armature, *B* the accelerating magnet coil, *R* the starting resistance and *P* and *N* the main line wires. As will be noticed, one terminal of the coil *B* is connected with the line-wire *N* and the other terminal to the point *D* on the starting resistance, thus shunting the armature and the portion of the resistance between the points *D* and *E*. The object of this construction is to make the magnet stronger when the motor is just started. If wire *C* were connected with point *E*, the current passing through the coil *B* would be directly proportional to the counter electromotive force of the armature, and this is directly proportional to the speed. Owing to this fact the first switch lever would not be closed until the armature ran up to a rather high velocity, say half speed, unless it were made so light as to be moved by a weak pull of the magnet. If the lever were made so light, it might fail to open sometimes, when the motor is stopped, and thus all the starting resistance would not be put back into the armature circuit.

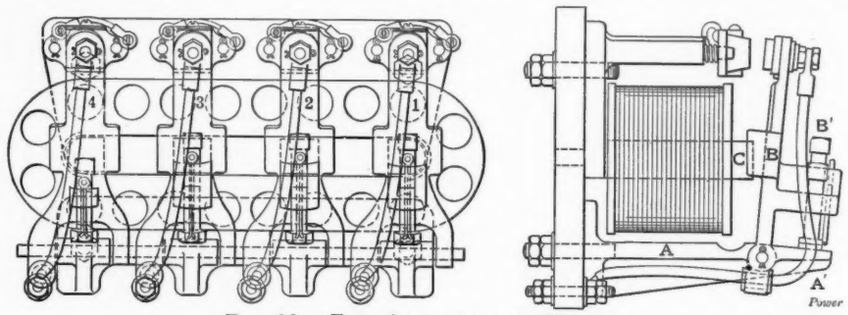


FIG. 83. THE ACCELERATING MAGNET

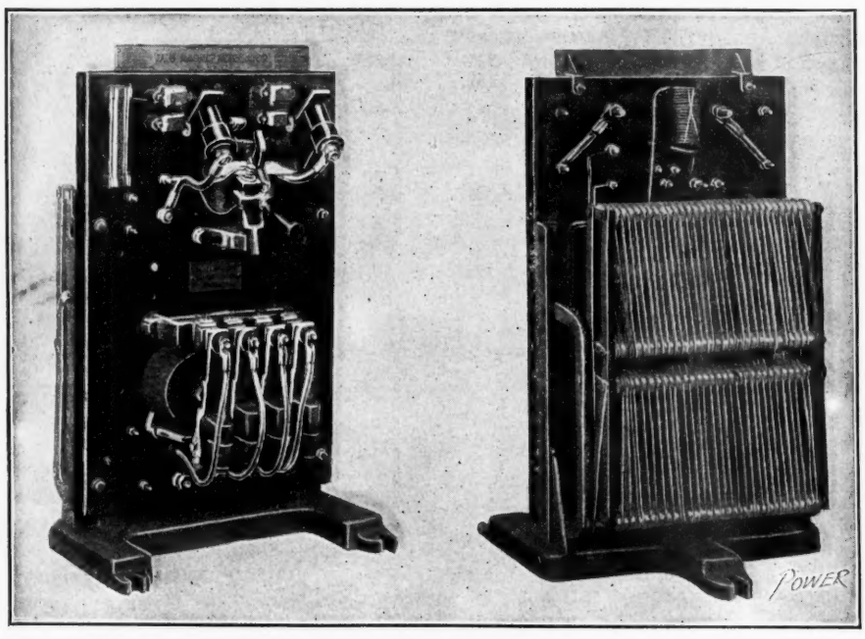


FIG. 82. CONTROL PANEL WITH ACCELERATING MAGNET, STARTING RESISTANCE AND CIRCUIT-BREAKER

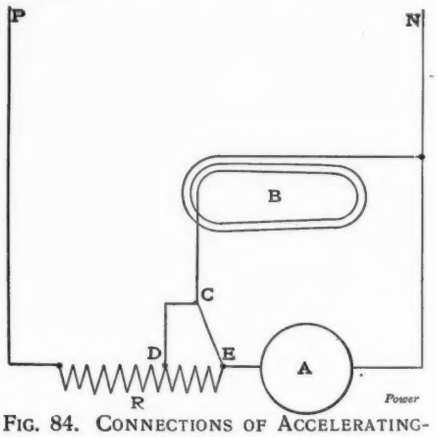


FIG. 84. CONNECTIONS OF ACCELERATING-MAGNET COIL

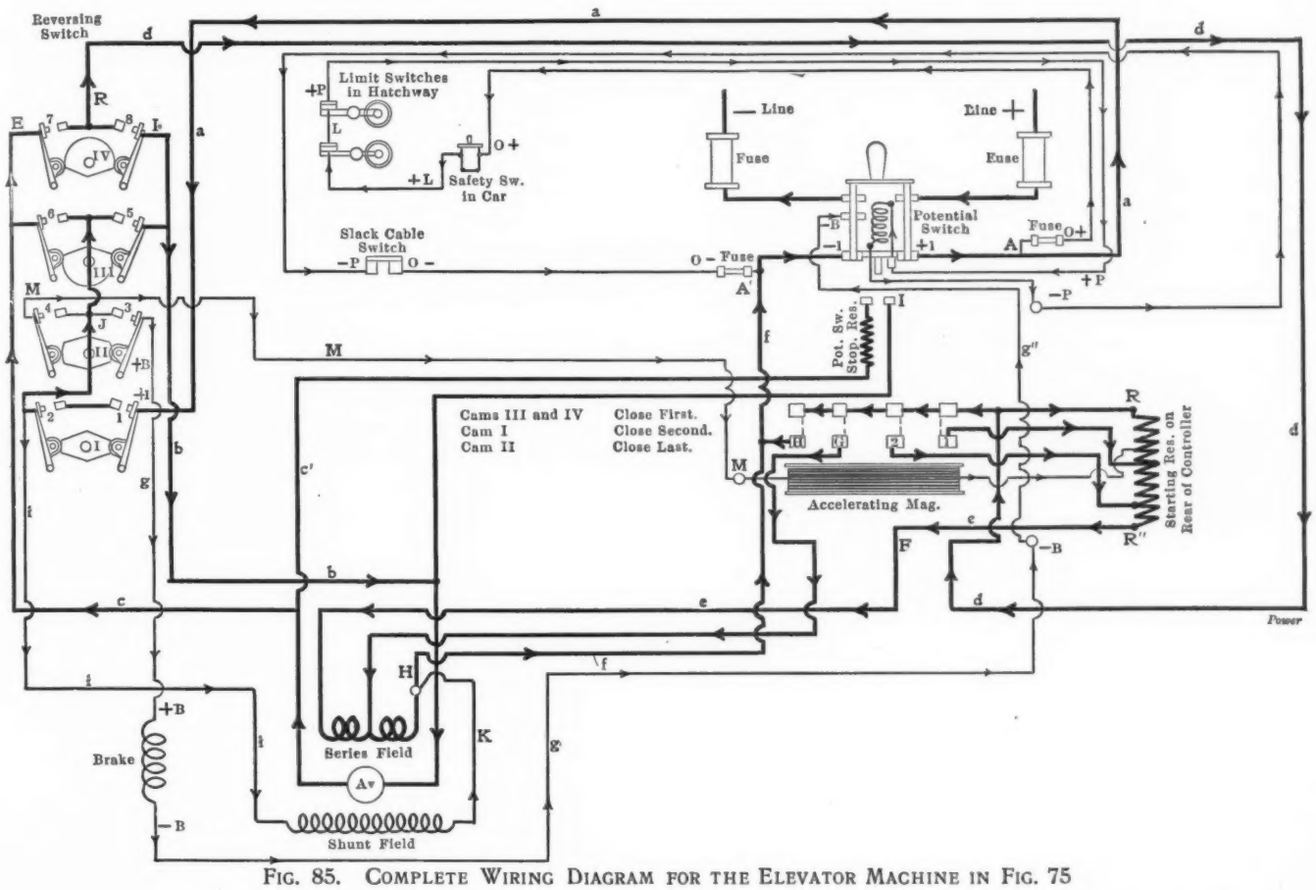


FIG. 85. COMPLETE WIRING DIAGRAM FOR THE ELEVATOR MACHINE IN FIG. 75

With the connection as shown, the current in the coil *B* is due to the electromotive force required to drive the current through the resistance from *D* to *E*, plus the counter electromotive force of the armature, and by properly locating the point *D* this can be made sufficient to operate the first switch at a comparatively low speed. The position of the connection *D* is determined by actual trial, it being located where it will cause the first switch to close at the speed required.

Electric Drive for Ships

At a recent meeting of the Institution of Civil Engineers of Great Britain, H. A. Mavor, a prominent designer of electrical machinery, read a paper on the application of electric generators and motors for transmitting power from the engines to the propellers of vessels. The following is an abstract of the paper, for which we are indebted to the secretary of the Institution:

At first sight it would appear that on a ship the direct connection between the power generator and the propeller renders unnecessary the use of any intermediate transmission device, and so long as reciprocating steam engines were the best attainable power generators it was possible to correlate the speeds of generator and propeller so as to gain the best efficiency of each. The steam turbine and the nonreversible internal-combustion engine introduce a new set of conditions. On land the turbine holds the field for the largest powers, and because its speed of revolution is unsuited to any ordinary mechanical direct application of power for industrial purposes, its evolution has been directly associated with electrical transmission. These turbines are many of them of the same order of magnitude as the turbines used on shipboard, and therefore a comparison of economy in the two conditions is inevitable.

Land turbines are more efficient than marine turbines for the reasons that the land engineer is freer than the marine engineer to adopt a suitable speed of revolution; that the land turbine runs at approximately constant speed for all loads, and can, therefore, be run on the governor, rendering easier the application of superheat and augmented vacuum; that on land it is possible to subdivide the power units to meet the conditions of varying load, and thus maintain at the smaller loads an efficiency not materially different from the efficiency at the full load of the system; that at sea change of power is directly associated with change of speed, and the whole of the power units must always be in motion while the ship is in motion. The same engine has to run the ship at 10 knots and at 20 knots, although the power varies very widely between those limits. Also the high economy on land of power production associated with electric transmission is largely due to the possibility of exact measurement of power under all conditions of load, giving a complete knowledge of the effect of all changes in the apparatus or in the methods of working it.

The proposition here made is to provide an electric equipment intermediate between the prime mover and the propeller, extending the limits of practical economy in each by modifying the speed restrictions which the prime mover and propeller impose upon one another, and providing that the prime mover may operate at or near the constant speed required for the attainment of maximum efficiency and full power, and that the power expended in driving machinery not required for work is reduced to a minimum or entirely eliminated. At full power all the elements of the generating plant

are in full operation and the whole power resources can be concentrated on driving the ship. When full power is not required the generating plant may be shut down in sections.

To accomplish these results special motors have been designed which give the necessary changes of speed and direction and permit the advantageous combination or elimination of the power generators. These motors involve no new electrical principle, but simply mechanical adaptation of well known designs. Alternating current alone is available for the purpose in question, and normal motors have, therefore, a fixed speed of rotation which is a simple multiple of the generator speed.

Two methods of speed change are proposed, each associated with a new form of motor; one of these is designated the "spinner" motor and the other the "multiple" motor. The principle of operation of the "spinner" motor is that an ordinary normal motor driving the propeller at a fixed speed, with the shaft and propeller directly connected, is so arranged as to be rotatable as a whole about the propeller-shaft axis, this rotation being accomplished by a second motor concentrically arranged outside the first, so that the main motor system may be rotated in either direction—again at a fixed speed which is a simple multiple of the generator speed—and the speed of rotation of the propeller shaft and of the propeller in the water is the algebraic sum of the rotation of the main motor and of the rotation imposed upon it by the auxiliary motor.

As both motors are reversible, there are three speeds in each direction: The speed of the main motor system, which is the middle speed; the speed of the main motor system minus the speed of the auxiliary motor system, giving the low speed, and the speed of the main motor system plus the speed of the auxiliary motor system, which is the full speed. The combination may be designed for any three speed ratios, such as 1, 2, 3; 2, 3, 4, etc. Any intermediate speeds required are attainable by adjustment of the turbine or engine governor, which can be operated economically through a range down to about 75 per cent. of full speed. The same method is applicable to nonreversible internal-combustion engines.

The "multiple" motor is an ordinary squirrel-cage induction motor in all respects, except that its stator is wound with two or more independent electric circuits each associated with a separate source of supply of energy. For example, the motor may be fed from two sources of supply at 25 and 50 cycles, respectively, the motor windings being for 46 and 92 poles. At full power and speed both windings are in operation under the most advantageous conditions; each of these windings results in a synchronous speed of 66 revolutions per minute. When the 25-cycle current is supplied to the 92-pole winding the speed is 33 revolutions per minute.

Either of these motors permits the use of two or more generators together in a single system without electrical connections or synchronizing devices.

The author then goes on to discuss the application of electric propulsion to certain definite types of ship, and also gives diagrams illustrating the saving in space obtained. The examples worked out are as follows:

1. In a freight vessel of 840 shaft horsepower the normal reciprocating-engine equipment with a single screw would weigh 570 tons for engines, boiler and fuel. The proposed equipment, consisting of three oil engines and generators, three motors and three propellers, would weigh only 270 tons, including fuel. Further, with coal at 20s. per ton and oil at 40s. per ton the saving in fuel cost on a total of £17 would be £5 6s. per day at full power.

2. In a similar freight vessel gas engines might be used. Taking an equipment of 770 shaft horsepower, and using three gas engines and one multiple motor, the respective weights of the normal and proposed equipments would be 446 tons and 229 tons. The consumption of fuel shows an equally favorable comparison.

3. A third freight vessel, but of 1030 shaft horsepower, is worked out for the purpose of illustrating the application of the multiple motor to steam turbines. One plant drives the ship under normal conditions; extra power is supplied by a small turbo-generator, and is used to keep up the ship's speed in heavy or contrary weather.

4. On a passenger vessel of, say, 16,200 shaft horsepower, the electrical equipment permits of a subdivision of the plant, so that at ship speeds lower than the maximum only part need be run, and that at full power. This advantage is gained without loss in full-power economy, and without additional complication.

CORRESPONDENCE

Electric Motor Drive

On page 836 of the issue of November 16, 1909, there appeared an article by H. J. Macintire, on "Electric Drives for Factories." In order that the readers of POWER may not be biased by the statements which this article contains, I beg to submit a few features in connection with individual drives and induction-motor installations which Mr. Macintire has omitted. Had he seen the individual induction motor driving machines and machine tools in some of the largest and best of modern equipped plants, and had he reviewed the expense sheet for these plants, I am sure his ideas in regard to individual drive with induction motors would have been very greatly changed.

No hard and fast rule can be laid down which makes the individual-motor drive the one to be used in each and every case. There are certain cases where a number of small machines can be grouped and driven by a small motor with much greater economy than with the individual drive; but there are very few other machine applications which do not lend themselves to individual drive with more economy and flexibility of operation and with a better and more practical layout of the equipment. In general, the advantages of the individual drive may be summed up as follows:

Increased output; saving in power due to elimination of frictional losses in shafting and belting; saving in labor by obviating the necessity of shifting belts, lacing belts, repairing friction pulleys, countershafting, etc.; convenience of placing any machine wherever desired without reference to shafting or crane location; increased light, convenience and freedom from dust and dirt due to the elimination of shafting and belting; increased safety and freedom from accidents to employees; the ability to operate a single machine overtime without having to operate any other machine; prevention of loss of power by running idle machines and shafting.

When Mr. Macintire sounded his note of group drive for factories he omitted the essential point of economy in the operation of the individual motor. A motor when running at its full rated load operates most efficiently, and, therefore, most economically. When one large motor is used to drive a number of machines from a line shaft, it is very often operated on a low load, and the efficiency of the motor is greatly reduced. With individual-motor drive, each motor is designed for the particular load it has to carry, and its design is therefore based on economy of operation. The motor is idle when the machine is idle, and therefore does not add to the expense of nonproductive energy consumption.

As to the general or main item of sav-

ing for electric-driven plants in a vicinity where electric power is easily obtained, the reduction is first in the capital outlay effected by the elimination of engine houses, boiler settings, flues, chimneys, etc., and next by the capital invested in equipment. The efficiency of most modern means of mechanical transmission as compared with electric equipment, I think, is in general quite contrary to the statements made by Mr. Macintire, even when scientific lubrication by oils of suitable viscosities is used and careful attention is given to the care of the line shafts and jack shafts. Careful observations and tests on plants have shown that the motor drive effects an increased efficiency first between engine and generator; further, in the distributing mains, and finally at each machine.

Another feature of electric drive, especially when mills and factories are built of fireproof construction, is the equipping of such factories so as to comply with the fire underwriters' rules and reduce the insurance to the lowest amount. In this respect the induction motor stands out prominently as being free from commutators and their attendant sparking, affording a most reliable and effective power system from every point of view, and saving hundreds of dollars that would otherwise be required for insurance premiums.

From the standpoint of working conditions, the individual motor, with the consequent elimination of the line shaft, has done much to make the workshop and factory more cheerful.

As to the induction motor itself, permit me to say that Mr. Macintire's attack is particularly interesting, because he has discovered several hitherto unknown faults in this type of apparatus.

The layout of the electrical equipment in the case cited must be unusually poor; a plant power factor of 65 to 75 per cent. is bad. On first consideration, it looks as if the motors are badly underloaded, giving the low power factors of small loads. Every engineer familiar with the operating characteristics of induction motors recognizes the importance of putting sufficient load on every motor if the power factor is to be kept up.

The guarantees for a 5-horsepower, three-phase, 60-cycle induction motor, running normally at 1140 revolutions per minute, are given by one of the prominent manufacturers as follows:

Per Cent. Load.	125	100	75	50
Efficiency, per cent.....	83	85	85	83
Power factor, per cent.....	88	85	80	68
Current input at 220 volts..	29	23.5	18.7	15

Mr. Macintire says: "The feeders were calculated for only enough current for the normal load, and no account was made of wattless current which will heat up the wires...It was a continual fight to keep the circuit cool." Now, isn't it absolutely necessary to take account of wattless current in order to determine the full-load current? The full-load current as marked on the motor name-plate takes in account the full-load power factor. Again, how is it possible to "heat up the wires" with a current greater than full-load current when carrying less than full load? He himself states that his motor, "apparently groaning under overload, was really not up to full load." If there is any one thing an induction motor will do it is to carry heavy overloads silently.

Mr. Macintire's suggestions for improving the power factor are also a little in error. If the power factor is so bad as to demand raising, a synchronous motor will, as he said, "do the job," but it is not necessary that "it must be arranged to take about 75 per cent. of the load to make any great improvement in power factor." There are many cases of synchronous motors running without load (called either synchronous condensers or rotary condensers) used to raise the power factor of a system carrying excessive inductive loads. Occasionally such a motor is given a partial load, but this is merely a convenient combination and not a necessity. Why "this cannot be done...as power is used elsewhere besides in the oil mill" is not apparent. Synchronous condensers are frequently used on central-station distributing circuits.

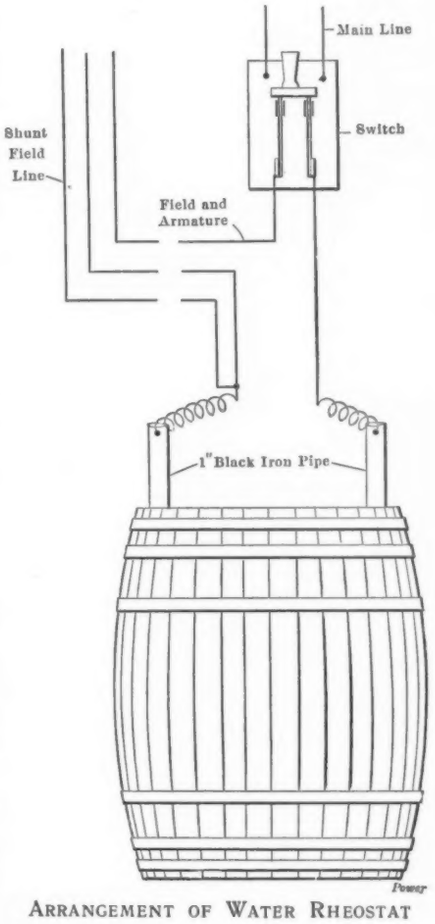
It is also suggested that two large motors be used instead of ten or twelve individual-drive motors. If every machine were used continuously, keeping full load on the motors, the power factor would be improved slightly, but if they are used intermittently, I cannot see the advantage of the group drive. For simplicity, let us assume that there are ten 5-horsepower motors now being used, and it is proposed to change to two 25-horsepower motors. For continuous service the power factor would be improved in the ratio of 85 to 89, or considering the effect of the line, the power factors should be approximately 80 and 84 per cent. for the two cases, respectively. Assume that half of the machines are to run continuously. With individual 5-horsepower motors five of them would be cut out and the remaining five would keep the power factor at 80 per cent. and take 118 amperes of current. With the group drive, each machine, when not in use, would have its belt shifted to an idler pulley and the two large motors each carry half load with a remittent power factor of 75 and a current input of 125 amperes. It will be noted that the operating conditions decidedly alter the case, but, in general, individual drive for machines of medium and larger sizes is the better scheme. The calculations submitted are approximate, but are in accordance with operating results.

D. H. BRAYMER.

New York City.

Water Rheostat

The starting box of a 20-horsepower direct-current motor burned out. To wait for a new one would cause 50 toolmakers to remain idle for two days. The foreman asked me what I could do to keep them busy. I said I could make a repair in half an hour. I filled an empty oil



ARRANGEMENT OF WATER RHEOSTAT

barrel with water, added a pail of salt, and connected it up as shown.

When starting up, the pipe connected to the line wire was taken out of the barrel, the switch closed, and the pipe slowly lowered into the barrel again. By the time the pipe hit the bottom the motor was up to speed. I ran for a day and a half with this arrangement.

E. E. WILLIAMS.

Kingston, Penn.

If an engine gets to pounding and it is doubtful exactly what is loose, pour some cylinder oil on the different bearings; when you reach the one where the pound occurs, the noise will be greatly reduced for a few moments owing to the cushion formed by the oil.

GAS · POWER DEPARTMENT ·

Everything worth while in the Gas Engine and Producer Industry will be treated here for the use of practical men

Efficiency Test of Otto Gas Engine

BY C. C. WINN

The test, which is the subject of this article, was made for the purpose of determining the most economical speed, under a given load, of an Otto gas engine, located in the gas-engine laboratory of Purdue University. The engine is rated at 10 horsepower at a speed of 270 revolutions per minute; it is of the single-acting type, working with the four-stroke cycle. The governor is of the weighted flyball type and regulates the engine speed on the hit-and-miss principle, cutting off and on the gas supply. Ignition is accomplished by means of a make-and-break igniter.

Each test was of 15 minutes duration and readings were taken every five minutes; 10-minute intervals were allowed between tests to get conditions as nearly constant as possible.

Five tests were made at 300 revolutions per minute; six tests at 270 revolutions; five tests at 240, five at 210 and five at 170 revolutions per minute. The speed was varied by weighting the governor.

The heat value of the gas was determined in the Purdue physical laboratory and found to be 650 Fahrenheit

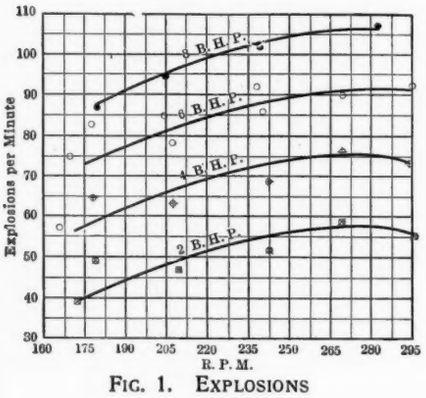


FIG. 1. EXPLOSIONS

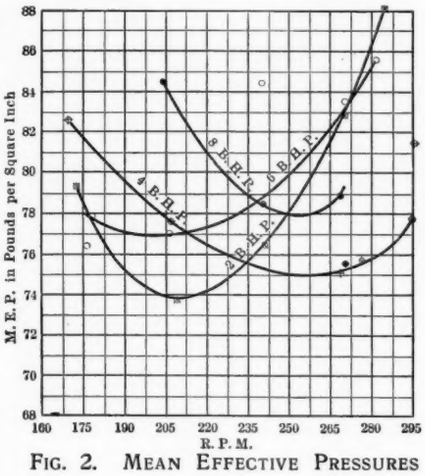


FIG. 2. MEAN EFFECTIVE PRESSURES

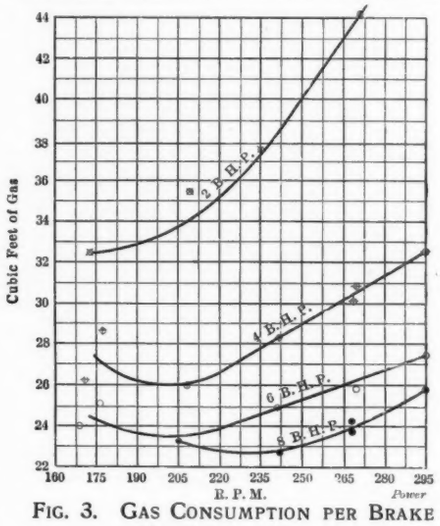


FIG. 3. GAS CONSUMPTION PER BRAKE HORSEPOWER-HOUR

TABLE OF RESULTS.

No. of Test.	Time.	R.P.M.	Brake Load.	B.H.P.	Explosions per Minute.	M.E.P.	I.H.P.	F.H.P.	Cubic Feet Gas Used.	Standard Gas per Hr.	Standard Gas per B.H.P. Hr.	Initial Temp. of Water, Deg. F.	Final Temp. of Water, Deg. F.	Wt. of Water, Lb.	B.T.U. to Water per Hr.	Heat Balance.			
																Per Cent. to Jacket Water.	Per Cent. to Eng. Friction.	Per Cent. to Exhaust and Radiation.	Thermal Eff., Per Cent.
	P.M.																		
1	1:00–1:15	295.2	10	1.87	45	81.52	5.12	3.25	23.3	90.7	48.5	61	158.9	59	23,104	39.2	14	38.74	8.06
2	1:25–1:40	294.2	20	3.73	63.9	77.63	6.81	3.08	31.2	120.91	32.4	60	157.8	66	25,792	32.75	10	45.09	12.16
3	1:50–2:05	294.5	30	5.6	82.9	70.11	8.1	2.5	39.9	153.6	27.4	60.6	161.5	82	33,095	33	6.35	46.4	14.25
4	2:15–2:30	294	40	7.46	102.2	68.72	9.79	2.33	49.7	191.3	25.6	58	162	108	44,928	36	4.7	44.05	15.25
5	2:40–2:55	293.8	50	7.32	118.4	70.18	11.59	2.27	57	218.2	23.4	58	161	132.5	54,696	38.5	4.05	40.73	16.72
6	3:15–3:30	270	12	2.06	49.2	72.87	5	2.94	23.7	91.2	44.2	60	159.5	42.5	16,864	28.4	12.4	50.33	8.82
7	3:40–3:55	270.5	24	4.12	66	75.54	6.95	2.83	32.2	124	30.1	61	159.5	62.5	24,525	3.4	8.9	47.7	13
8	4:05:4.20	269.3	36	6.15	79.9	75.21	8.38	2.23	41.3	159	25.8	63	161	92	38,024	37.6	5.5	40.9	15.9
9	4:25–4:40	268.7	48	8.18	96	76.08	10.18	2	51	195	23.8	61.5	159.5	139	54,488	42.8	4	36.8	16.4
	P.M.																		
10	1:10–1:25	242.5	13	2	41.6	76.45	4.44	2.44	19.4	75.4	37.6	64	161	32.5	12,675	25.9	12.7	50.8	10.5
11	1:30–1:45	242	26	3.99	58.2	78.53	6.37	2.38	29.2	114.5	28.4	63.5	160	58	22,504	30.6	8.2	47.4	13.75
12	2:00–2:15	241	39	5.97	75	78.63	8.22	2.25	38.2	148.2	24.8	75.5	159.7	98	33,006	34.3	5.95	44	15.74
13	2:20–2:35	239.5	52	7.9	91.4	78.63	10.02	2.12	46.7	180.2	22.8	60	158.2	103	40,458	33.4	4.06	45.4	17.15
14	2:40–2:55	237.2	70	10.54	114.8	78.3	12.54	2	58	223.8	21.3	59.6	161	134.5	54,553	37.4	3.48	40.7	18.4
	P.M.																		
15	2:20–2:35	209.5	15	1.99	36.2	73.72	3.72	1.73	18.1	70.5	35.4	64.3	158	27.5	10,340	22.6	11.3	58.57	7.55
16	2:40–2:55	207.75	30	3.96	53.06	77.54	5.74	1.78	26.6	103.4	26	63.8	158	45	17,010	25.3	6.74	52.96	15
17	3:00–3:15	206.75	45	5.9	68.06	77.07	7.31	1.41	35.8	139	23.5	64	159	84	32,004	3.54	3.96	43.9	16.7
18	3:25–3:40	204.5	60	7.79	84.52	76.16	8.98	1.19	46 9	181.2	23.3	62	159	110.5	42,764	3.63	2.56	44.3	16.8
	P.M.																		
19	2:20–2:25	173	17.5	1.92	29.4	81.62	3.34	1.42	16.3	62.5	32.5	61.5	161	30.5	12,078	29.7	8.9	49.4	12
20	2:40–2:55	170.5	35	3.79	46.7	82.31	5.34	1.55	25.5	99.4	26.3	64	160	52	19,906	30.8	6.1	48.2	14.9
21	3:00–3:15	168.5	52.5	5.62	64.2	81.55	7.28	1.66	33.8	132.5	24	61	160	84	33,197	38.8	4.88	40	16.6

heat units per cubic foot at a pressure of 14.7 pounds per square inch and 62 degrees Fahrenheit. This is the "standard gas" referred to in the accompanying table of results.

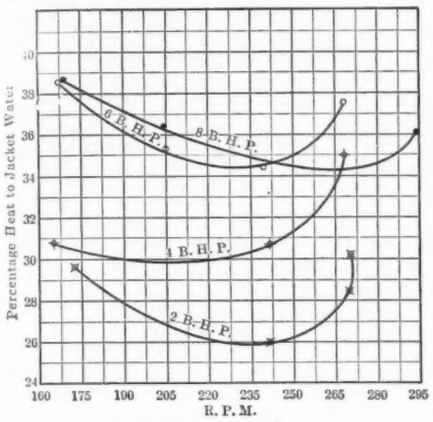


FIG. 4. HEAT IN JACKET WATER

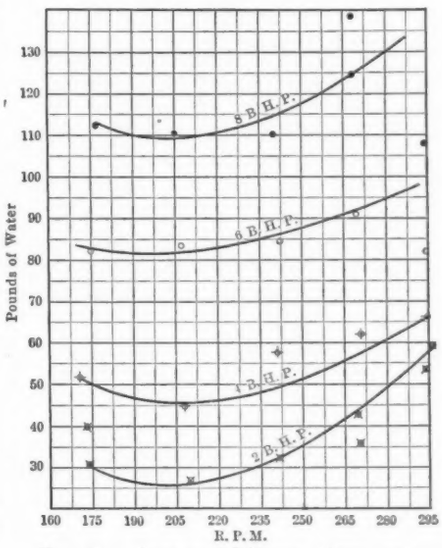


FIG. 5. COOLING WATER USED PER QUARTER HOUR

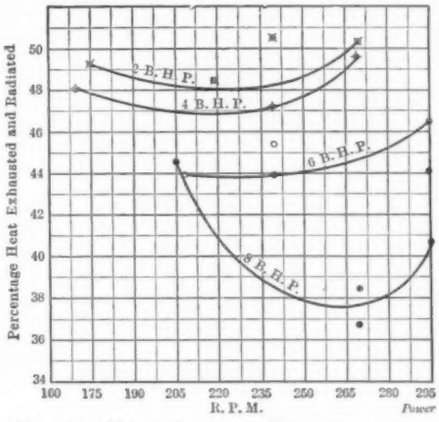


FIG. 6. HEAT LOST IN EXHAUST AND BY RADIATION

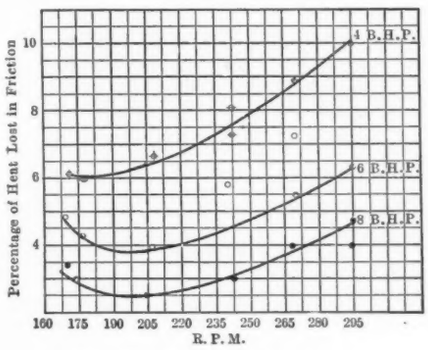


FIG. 7. FRICTION LOSS

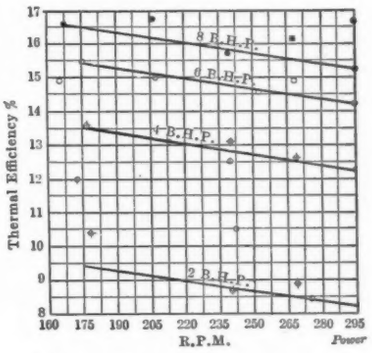


FIG. 8. THERMAL EFFICIENCY

The engine cylinder was 6¾ inches bore and 15 7/16 inches stroke, with 31.2 per cent. clearance. The igniter was set to act 10 degrees ahead of dead center.

The accompanying table, charts and diagrams give the results of the tests more clearly and concisely than words could.

Summary. (*a*) For a given brake horsepower, the number of explosions per minute varied with the speed and the curve increased more rapidly from 170 to 210 revolutions per minute than in any other range of speeds.

(*b*) The fuel consumption varied almost directly as the speed between 235 and 295 revolutions per minute.

(*c*) The variation in mean effective pressure was greater at lower speeds. The maximum mean effective pressure was secured at high speeds. The highest thermal efficiency occurred at low speeds, the brake horsepower being constant.

(*d*) The friction horsepower varied directly as the speed.

(*e*) The amount of cooling water required to maintain a constant jacket

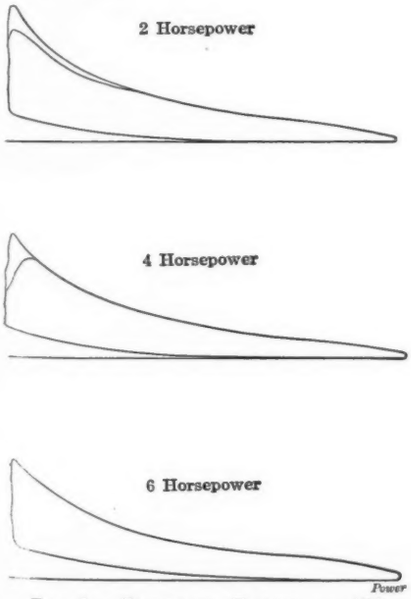


FIG. 9. DIAGRAMS TAKEN AT 170 REVOLUTIONS PER MINUTE

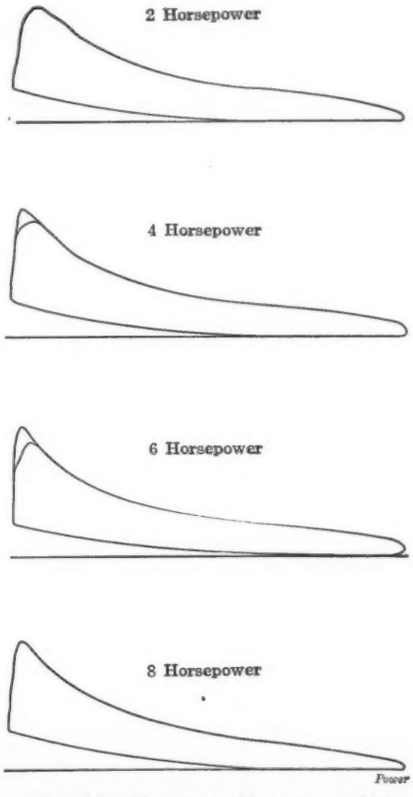


FIG. 10. DIAGRAMS TAKEN AT 216 REVOLUTIONS PER MINUTE

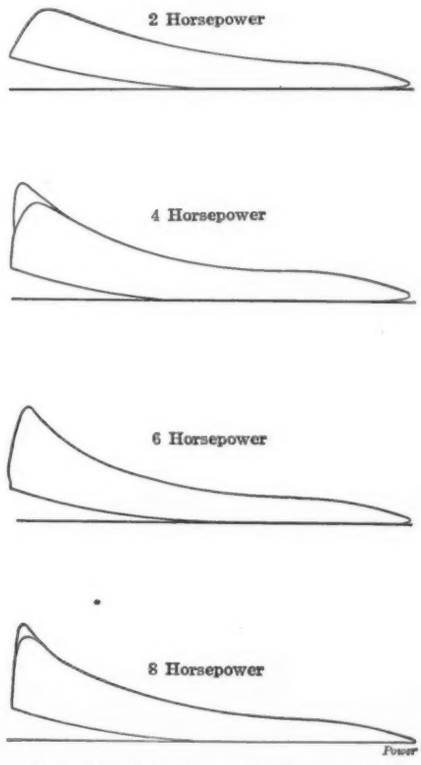


FIG. 11. DIAGRAMS TAKEN AT 240 REVOLUTIONS PER MINUTE

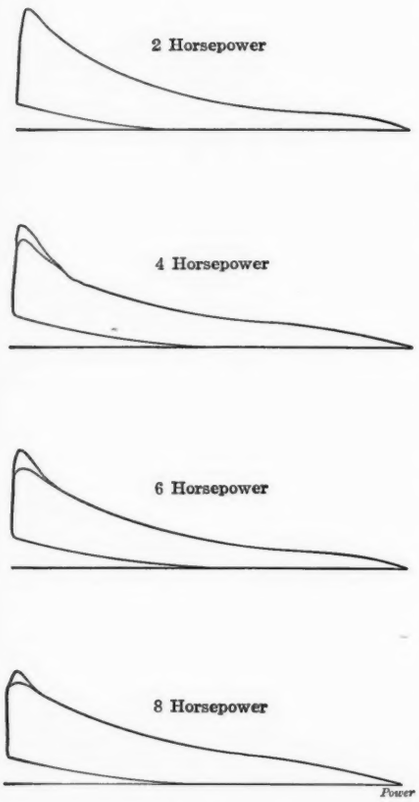


FIG. 12. DIAGRAMS TAKEN AT 270 REVOLUTIONS PER MINUTE

temperature is far greater at high than at low speeds.

(*f*) The per cent. of heat lost in the exhaust and by radiation at two, four and six horsepower increased from 220 to 295 revolutions per minute; but at eight horsepower this item decreased for speeds up to 650 revolutions per minute and increased directly as the speed up to 295 revolutions per minute.

(*g*) The percentage of heat to the jacket water decreased from 170 to 230 revolutions per minute at two, four and six horsepower; also from 170 to 295 revolutions per minute at eight horsepower.

(*h*) The percentage of heat lost by engine friction varied almost directly as the speed.

(*i*) The thermal efficiency at all loads decreased as the speed increased. This is more marked at the lower speeds.

From the standpoint of economy in fuel consumption, the proper speed for this engine is about 240 revolutions per minute, with a brake load of from six to eight horsepower.

It is reported in *The Engineer,* of London, that 78 electric furnaces now exist in the steel works of the world, of which 35 are on the induction and 43 on the arc principle.

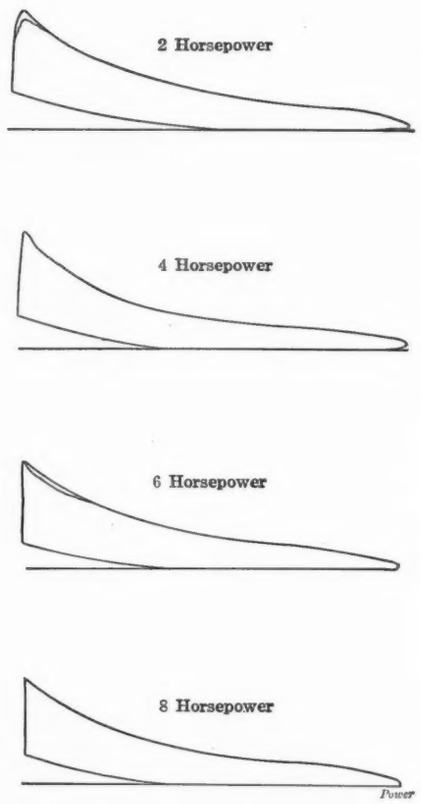


FIG. 13. DIAGRAMS TAKEN AT 296 REVOLUTIONS PER MINUTE

CORRESPONDENCE

How Could the Diagram Be Improved?

I submit herewith for the criticism of other readers two diagrams taken from a suction producer-gas engine. This engine is rated at 280 horsepower, and runs at 176 revolutions per minute. It is of the twin, single-acting type, with cylinders 21¼x32 inches.

The diagram shown in Fig. 1 was taken with a 160-pound spring, while the engine was operating with a light load. The wavy compression line is undoubtedly due to a sticky indicator piston.

Fig. 2 shows a "pump" diagram, which was taken with a 10-pound spring and with a stop on the piston of the indicator to prevent injury to the instrument. This diagram is taken in order to show the events involving the lower pressures of the cycle to a larger scale for the purpose of investigating the valve settings. In this case, as the scale of the spring used was 10 pounds per inch, the total hight of the diagram is about 20/160 = ⅛ of the hight of the complete diagram shown in Fig. 1. The line *A*—*B* is the atmospheric line. The expansion pressure of the burning gases is improperly indicated by the line *a*—*h*, because the pressure is so great that the piston of the indicator is against its stop until near the end of the explosion stroke after the exhaust valve has opened, when the pressure drops sufficiently to allow the indicator piston to recede from its stop; then

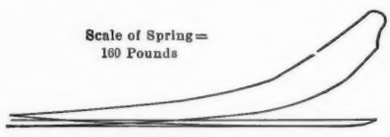


FIG. 1

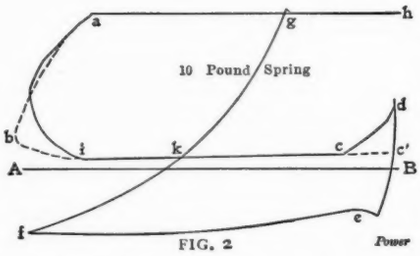


FIG. 2

the exhaust line *a*—*i*—*c'* is drawn. The opening of the inlet valve and the movement of the piston outward on the suction stroke causes the pressure to drop along *c'*—*e* below atmospheric pressure and the line *e*—*f* is drawn as the piston sucks in the fresh charge. Shortly after reaching the outer center the inlet valve closes and compression begins, as shown by the line *f*—*g*. The further compression and subsequent explosion of the charge take place at too high pressures to be shown in this diagram.

In the diagram under consideration, I should say that the exhaust valve closed at *c*, which caused the rise in pressure indicated by the line *c*—*d*. The inlet valve opened at *d*, permitting the immediate drop of pressure *d*—*e*. The small rise at *e* is probably due to the inertia of the entering gas, following the initial rush upon the opening of the inlet valve.

I have a few questions to ask. Could the effective area of the diagram be increased by opening the exhaust valve earlier? Would the resultant exhaust line be represented by *a*—*b*—*i*, which would mean an increased area of the diagram, or would the area cut off by the rapidly falling pressure immediately after the valve was opened more than equal that added at the extreme end of the stroke?

Notwithstanding Mr. Tilden's statement in the October 12 number, quoted from Mr. Ziegler in *The Rudder,* that both the inlet and the exhaust valves should not be open at the same time on account of

backfiring, I have operated gas engines up to 400 horsepower rated capacity in which the inlet valve opened 20 degrees of crank travel before the exhaust valve closed, and have experienced practically no trouble from backfiring. The fuels used were both natural and producer gas. Furthermore, this practice was taught me by a very prominent gas-engine manufacturing firm. The effect of this upon the diagram would undoubtedly be to round off the end *c—d—e* of the diagram and thus cut down the area *k—c—d—e—f—k*, which is negative work. This would mean an increase of the effective work which, however, would be too small to be noticeable on an ordinary diagram taken with a 160-pound spring. I regret that I have no diagrams taken under these conditions with which to verify my statements.

Many of the present makes of engines govern by the quantity method; that is, by throttling the inlet and keeping the quality of the mixture constant. It is evident, I think, that the throttling will cause a further downward slant of the line *e—f*. If this is true, the point *f* will be lower on light loads than on heavy loads and the ensuing compression pressure will be less. The fact that the pressure at the end of the compression is higher on heavy loads means that the temperature of the compressed charge will be higher; moreover, on heavy loads the walls of the cylinder will undoubtedly be hotter, and these two facts would tend to cause trouble in the form of preignition if all other conditions—principally the composition of the charge—were favorable. Am I right?

J. C. PARMELY.

Urbana, Ill.

[You are right—as to reasoning process, but in actual engines the full-load compression values are the basis of design. That is, the full-load compression pressure and temperature are such as to avoid trouble from premature ignition, and the light-load values are left to take care of themselves, so to speak.—EDITOR.]

Wear of Gas Engine Piston Rods

Referring to L. B. Lent's letter in the issue of December 7, 1909, on uneven wear of gas-engine piston rods, I will give what experience I have had with the same trouble. We have a horizontal tandem double-acting engine running on coke-oven gas, which is very high in sulphur, the average of ten analyses being 2.24 grains per cubic foot. The engine shows more wear on the intermediate rods than it does on the other rods, and I am sure this is due to the intermediate rods being cooler than the front and rear rods, as the water enters the intermediate crosshead at an average temperature between 120 and 130 degrees Fahrenheit, and leaves the front and rear rods at an average temperature between 165 and 175 degrees Fahrenheit. When the gas is high in sulphur the intermediate rods turn black and it is a hard matter to keep them lubricated; on the other hand, the front and rear rods stay bright, doubtless due to the higher temperature.

I think Mr. Lent is right in his belief that a cold rod condenses moisture which with sulphur forms sulphuric acid and eats up all the lubrication on the rod. The wear on the rods of this engine is about 6 to 1; that is, the parts of the rods which enter the cylinder wear six times as much as those parts which only enter the packing. This same engine running on producer gas, relatively low in sulphur, will not require one-third the oil to keep it lubricated that it does on coke-oven gas, and will not show nearly as great wear on the rods.

We have now got over most of our troubles by installing an oxide scrubber to remove the sulphur, the oxide being composed of 90 pounds of cast-iron borings, 1 bushel of pine shavings and 10 pounds of sal-ammoniac. The following tabulation will show the reduction of sulphur made in the scrubber; sulphur determinations were made in gas samples taken before and after passing through the scrubber.

POUNDS OF SULPHUR PER 1000 CUBIC FEET.

Before.	After.	Reduction. Per cent.
0.397	0.093	76.7
0.335	0.025	92.7
0.384	0.104	72.9
0.283	0.010	94.2
0.287	0.088	69.4
0.385	0.026	93.3
0.286	0.119	58.5
0.293	0.041	86.2
0.297	0.044	85.0
0.261	0.041	84.2

It may be of interest also to know that at one time we used a water-cooled packing cage on this engine, and when this was in use the wear was a great deal more than at present. At present the packing cage is water-cooled only where it enters the cylinders and we do not have nearly as much trouble with it as formerly.

NATHAN AUCHENBACH.

Lebanon, Penn.

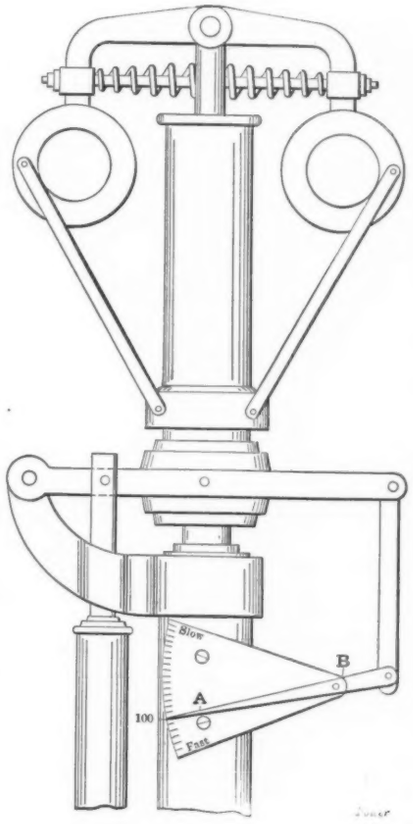
Gas Engine Speed Indicator

As a general thing, one can tell within a few revolutions the speed of an engine by the sound and motion of the crank, but there is no way of accurately knowing, unless some sort of a gage is placed on the engine.

In one particular case in which a large gas engine was running, the engineer had a means of telling just what the engine speed was by a device similar to that shown in the illustration.

To the stem of the governor was attached a painted piece of tin, shape as shown, on the curved portion of which graduations were made to correspond to certain speeds. From the arm of the governor a lever arm extended down and was attached to the end of the pointer *A*, which was pivoted at *B*.

If the engine is stopped the pointer



SPEED INDICATOR

moves up the graduation toward "slow." As the speed increases the end of the pointer gradually descends on the segment of the circle until it reaches the point corresponding with the average speed at which the engine is supposed to run, in this case 100 revolutions per minute. In case the engine is running fast, the pointer will show the number of revolutions above the predetermined speed.

This device, in this instance, enabled the engineer to keep track of what the men in the producer plant were doing, and keep their work up to the standard and the proper quality of gas produced. It worked out very nicely in this case, for as soon as the gas became weak, due to the neglect of the producers or other reasons, the engineer's attention was directed to it by means of his speed indicator, and the men in charge of the producer were at once notified and matters righted.

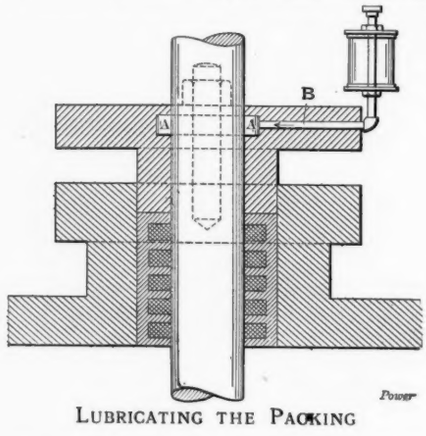
The easiest way to withdraw a feather from the end of a shaft without bending it is to hold a wrench on the head and then drive in the wedge.

FROM·READERS·WITH SOMETHING·TO·SAY

Practical Information from the Man on the Job. A Letter good enough to print is good enough to pay for

Lubricating Piston Packing

Some years ago I was running a 1500-horsepower vertical blowing engine, with piston rod 7 inches in diameter and packed with metallic packing which gave considerable trouble by blowing, and if tightened would get hot. Eventually the piston had to be removed for repairs, and I suggested that we take the packing gland off and fix it so the rod could be lubricated. The gland was put in a lathe, and with a square-nose inside tool a groove was cut as shown at *A*, beginning ⅜ inch from the face of the gland. The groove was ½ inch wide and ½ inch deep. A hole *B* was drilled for a ¼-inch pipe tap from the out edge of the gland to the groove. After tapping the hole a short ¼-inch nipple and ell was screwed in place and an oil cup attached, as shown. By this means the rod was kept well lubricated with valve oil which was fed to the groove from the oil cup.



LUBRICATING THE PACKING

After this was done the rod gave no more trouble and the gland could be tightened to prevent leaking and all heating disappeared.

D. M. GROVE.

Covington, Va.

Bedplate Repair

Some time ago, in order to transmit more power, it became necessary to replace an old cylinder with a new one of larger diameter. The engine is of the plain slide-valve type, with a box bed, Figs. 1 and 2. In order to accommodate the new steam chest it was found necessary to cut a piece out of the top of the bedplate, as shown at *A*, Fig. 3. The work was completed, and the engine put in operation. Everything went well for a few days when a crack appeared, as shown at *B*, Fig. 3, opening and closing at each stroke.

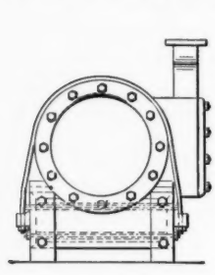


FIG. 1. END VIEW

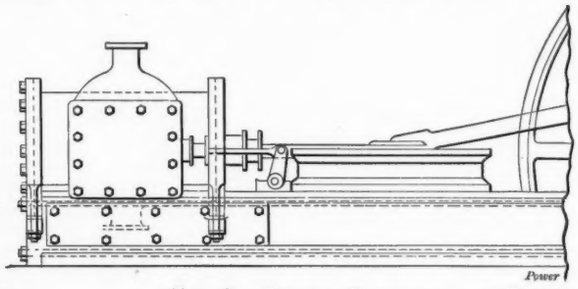


FIG. 2. REPAIR CASTINGS AND BANDS ASSEMBLED IN POSITION

Two heavy right-angle castings with two lugs on each were made so as to conform to the shape of the bedplate, as shown in Figs. 1 and 2. Ten ⅞-inch bolts were run through both sides of the bedplate, with nuts on each end. One-inch gas pipe cut to fit between the sides of the bedplate was placed over each bolt to prevent springing the bedplate. Four 1½-inch bolts were run longitudinally through the bedplate. Two 1x4-inch straps with bolt ends welded on were made to conform to the circle of the cylinder, the ends projecting through the lugs, as shown in Figs. 1 and 2. The engine has been operated over a year since the repair, and seems as firm as it originally was.

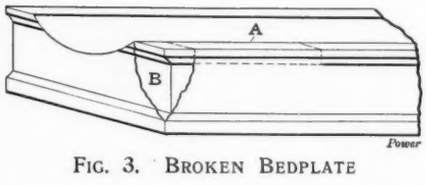


FIG. 3. BROKEN BEDPLATE

CHARLES J. HALLORAN.

Avoca, Penn.

Check Valve for Blowing Engine

I would like to call attention to the method employed at the smelting plant of the Calumet & Arizona Mining Company, Douglas, Ariz., to prevent cylinder accidents. In the discharge piping, just above each blowing cylinder, is located a check valve, which is held open, when the blowing engine is in operation, by a lever and counterweight. When for any reason the engine is shut down the engineer at once releases the counterweights and closes the check valve.

The device is quite simple, and it would appear that something of this sort should be provided in the discharge piping of all air-compressing or blowing engines having mechanically operated discharge valves. This would also apply in the case of an engine-driven rotary blower.

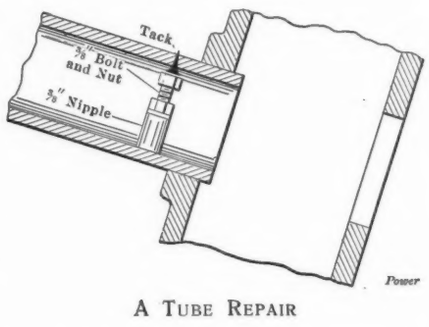
C. N. HARVEY.

Douglas, Ariz.

Plug for Hole in Boiler Tube

The accompanying sketch shows an expedient adopted to temporarily stop a leak in a 4-inch tube of a Babcock & Wilcox boiler.

The leak was just inside the back header, and about the center row. It was hard to locate, but after diligent search, with an improvised extension torch on the end of a ¼-inch rod, the leaky tube was found. The water being drawn off and the tube cap removed, a light rolling with an expander was tried which should have dried it up, but it didn't, so the water was again drawn off and the tube rolled a little tighter this time, but the leak still existed when the boiler was again filled, showing the leak in the same place.



A TUBE REPAIR

A further search disclosed a very small hole on the top of the tube, close against

the header. I suggested a soft patch, held in place by a jack bolt. This idea being improved on led to the repair being made as shown, which was in place two months before an opportunity occurred to allow the removal of the tube.

The lesson taught by this incident was to first locate the leak before attempting to tighten the tube in the header. A very little more rolling would, I feel certain, have resulted in a cracked header.

P. J. KEATING.

Streator, Ill.

Cover Plate for Follower Bolts

A great many engines have been wrecked by follower bolts breaking or coming loose. Most engines have about ¼-inch clearance between piston and cylinder head. I set my mind at ease by putting in a 1/16-inch steel plate large enough to cover the countersunk holes into which the follower bolts fit. The plate is held in position by two ⅜-inch tap bolts. In case a follower bolt breaks, it cannot drop out and cause trouble. The heads of the ⅜-inch bolts are filed off until there is just enough stock left with which to turn the bolts home.

There is not much danger of the ⅜-inch bolts breaking as there is no strain on them and I always tap the holes so that it is necessary to use a wrench when putting the bolts in.

OAKES KYGER.

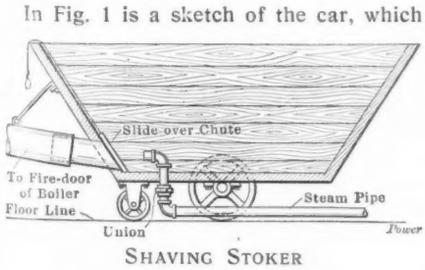
Danville, Ill.

A Shaving Stoker

I am the engineer, fireman, piper and all the rest at a railroad repair shop, and I have to burn shavings from two large planers just to get rid of them.

When I came, about two years ago, I had to shovel the shavings into the furnace. It took twenty minutes to shovel them in, and I have about seven car loads a day, and in hot weather it was no fun.

In Fig. 1 is a sketch of the car, which



SHAVING STOKER

is 9 feet long, 4 feet wide, 4 feet deep, tapering back from top to bottom. It had a sheet-iron pipe, 1 foot long and 8 inches in diameter, soldered and riveted to the center and front bottom of the car. Another pipe of sheet iron, 6 feet long and 8 inches in diameter was tapered to fit on it, an eyebolt and rod supporting the pipe. There is a ¾-inch pipe fitted with a union to couple to the steam pipe, also on ell fitted to the bottom of the car so that a jet of steam can blow through the collar. Two ¾-inch bolts are screwed in the bottom of the car for adjusting the pipe, so that it will enter the furnace door. A short tin slide prevents the shavings from entering the collar while filling the car.

With this device I can easily empty one of these cars in three minutes. The jet of steam blows the shavings through the pipe, and all I have to do is to push them over to the jet of steam. The jet of steam blows them through the space from the ¾ pipe to the hole in the collar, which is about 18 inches.

J. W. TATTERSALL.

Providence, R. I.

Engine Wreck

A 250-horsepower, side-crank engine running at 160 revolutions was wrecked under rather unusual circumstances. The engineer had shut down as usual, at 6 o'clock. After supper he returned and put in some new packing, after which he ran the engine for about 15 minutes to try it out. He closed the throttle and the engine made about three revolutions when the crash happened. When the engineer had collected his senses sufficiently to look the situation over, he found the cylinder head and steam chest badly broken and the follower plate cracked in halves.

As the drips were open and the throttle closed, it is my opinion the wreck was caused by a part of the follower plate, possibly a nut, falling to the bottom of the cylinder and being forced against the head on the return stroke of the piston.

W. C. MAGEE.

Germantown, N. B.

Trouble with Turbine Pump

We have a two-stage turbine pump of 250 gallons per minute capacity driven by a 25-horsepower single-phase motor. The suction head is about 8 feet and the discharge about 130 feet. The suction pipe is 6 inches in diameter and about 100 feet long; 60 feet is below water level. The pump worked all right for about 2½ months when it developed a leak in the stuffing box which we repacked; then it worked well for a few days more. The vacuum gage showed 15 inches and the friction head in the delivery pipe was about 8 feet. The vacuum gage was located about 4 feet above the center of the pump. When the pump began working badly again it showed signs of poor suction. An examination failed to disclose any leak. The vacuum gage registered only 8 inches and the capacity of the pump was reduced to about 30 per cent. of the original.

We took the cap off but could see nothing in the upper passages to indicate a stoppage. Owing to limited time and facilities we did not take the chute case apart nor the impeller out, but after a study of the sectional areas it seems impossible that either could be stopped up. A piece of iron-wire door screen had been tied around the end of the pipe as a strainer but has since rusted off. There is little chance, however, of foreign matter entering the pipe as it draws from a still-water pond.

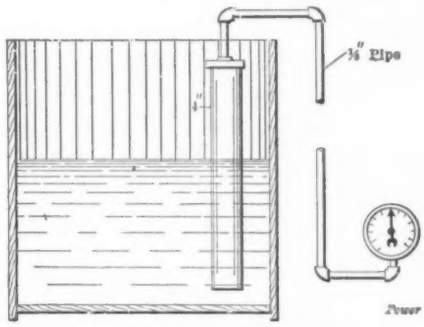
I have always understood that a turbine pump with a leaky suction would not work at all. This one works at about 30 per cent. capacity. I would like to hear from those who are more familiar with turbine pumps as to what is the trouble.

H. S. WILDERMUTH.

Lamoni, Ia.

Water Tank Indicators

The most convenient way of making a water-level indicator is to install a piece of 4-inch pipe vertically in the tank, on



WATER-LEVEL INDICATOR

top of which is screwed a 4x⅛-inch reducing cap, the bottom end of the pipe being left open, and supported about an inch from the bottom of the tank.

A line of ⅛-inch pipe is run to a desirable point and a low-pressure gage screwed on the end of the line.

As the tank fills up it is evident that the air entrained in the 4-inch pipe cannot escape, hence it must undergo compression, and since the rate of compression depends on the hight of the water in the tank, the gage reading will increase as water rises in the tank. Paste a disk of paper over the old dial and recalibrate the new dial so as to read feet of water.

Where the tank is located a great distance from the gage it is better to incline the large pipe in the tank so that a greater volume of air is displaced, thus making up for drop in the small pipe line.

This system works—works all the time—and the only thing that is more certain

is to go up to the tank and peep in occasionally.

W. McAUDELL.

Brooklyn, N. Y.

Why Does the Vacuum Improve?

Our Bulkley condenser serves a 15 and 26 by 17-inch, tandem-compound engine running at 200 revolutions. We carry 120 pounds steam pressure. The injector water has a temperature of about 55 degrees. The condenser is connected in the usual manner. The system is absolutely tight.

When starting the condenser with the engine carrying about 70 per cent. of full load we get a vacuum of about 26 inches. Other things remaining constant, the vacuum will stay the same under all loads.

There is a 1½-inch valve opening into the exhaust which is used to break the vacuum. Now, simply by opening this valve and then closing it quickly, the vacuum will pick up to 28½ or 29 inches and remain there no matter what change in load the engine may get.

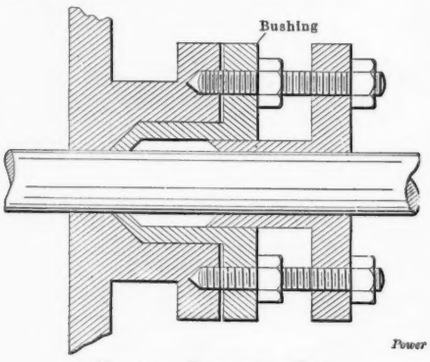
The vacuum gages are known to be correct. I cannot explain why the manipulation of the valve helps the vacuum and would be glad to have the opinions of POWER readers.

W. F. SAYLES.

Taunton, Mass.

Bushing a Stuffing Box

The figure shows a method of reducing the size of a stuffing box. Of course, the necessity for making such a change does not occur often, yet there are cases in which it may be desirable to do so.



BUSHED STUFFING BOX

The engine on which I used this kink is a cross-compound vertical, having both rods packed with metal packing. For certain reasons it was decided to remove the metallic packing from the low-pressure rod and substitute a special fibrous packing. But the cost of packing would be considerable on account of the size of the stuffing box. The diameters of the rod and box were 2¼ inches and 5⅜ inches respectively. This would require rings 1 9/16 inches thick, and about six pounds of the packing to fill the box. In bushing the box, as shown, we were able to use ¾-inch packing, thereby greatly reducing the cost.

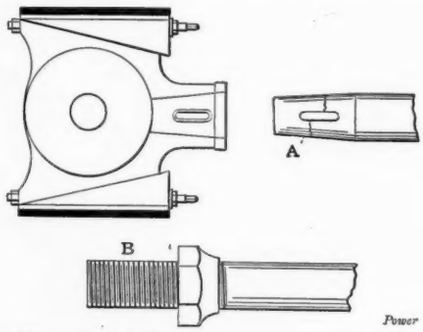
The results from this change were satisfactory.

J. B. CLAPPER.

Cleveland, O.

Repair of Broken Piston Rod

A short time ago the piston rod in our Corliss engine broke in the slot of the taper end where it was keyed into the crosshead neck, as shown in the sketch at *A*. The accident came near costing the writer his life, as he had just passed the cylinder head about two minutes before the crash came, and had passed the crank side of the engine but noticed no unusual sound or knock. The break was caused by a crack which had developed inside the slot in the rod and could not be detected while connected up. The piston and rod went through the back end



REPAIRS OF BROKEN CONNECTING ROD

of the cylinder, breaking the rings and also a piece from the piston, which is of the solid type. It broke the head into 11 pieces, the cover into six pieces, pulling eight ⅞-inch studs into and stripping two studs from the cylinder casting.

I was asked to furnish the necessary data to have a new rod and piston made at a machine shop, and after some study concluded the repair would be much more substantial if the rod were threaded and screwed in the crosshead, as shown at *B*. This made a permanent repair and one that was highly indorsed by the machinist and very satisfactory to the management. It did away with the taper and wedge, which had been the cause of a similar accident some years ago.

I may be wrong in my belief, but I cannot help thinking that the taper-and-wedge style of connection is not good practice in engine building. The taper-and-wedge construction reduces the cross-section of the metal at a point that receives as much or more strain than any other part of an engine, and therefore should be avoided wherever possible.

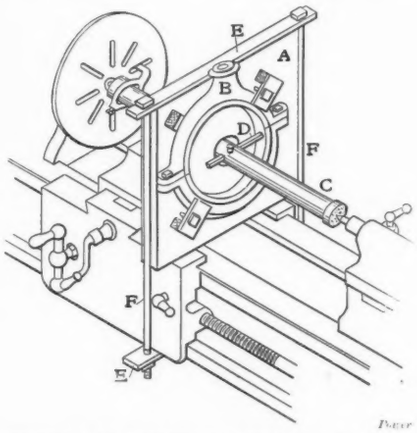
I would like to hear from other readers of POWER and also from builders on this subject. I have noticed some builders still use the taper-and-wedge connection, while the majority use the thread and jam nut. Some may credit this accident to a slug of water in the cylinder, but it was not so in this case, as the engine was working under a moderate load, the pressure was 115 pounds, and there were about two gages of water in the glass. Besides the boiler does not prime.

E. C. BILLAN.

Moundridge, Kan.

Boring an Eccentric Strap in a Small Lathe

Having occasion to bore out an eccentric strap after it had been babbitted, and as the lathe would not swing the



BORING AN ECCENTRIC STRAP IN A SMALL LATHE

strap onto the faceplate, I bored the strap as shown in the accompanying sketch. The boring bar *C* was made of a piece of pipe capped at each end, with the tool set in the pipe and held with a set screw, as shown at *D*. The strap *B* was mounted on a piece of 2-inch plank *A*, and held as shown in the drawing. This plank is fastened to carriage of the lathe with straps *E E* and with bolts *F F*, the upper part of plank being steadied by a bolt or lag screw which is screwed into the plank and held by a tool post, not shown.

By taking a light cut and using a fine feed the job was done in good shape.

R. L. MOSSMAN.

Tampa, Fla.

What is said to be the longest railroad train ever drawn by a single engine left Roanoke, Va., on December 17, for Norfolk over the Virginian railway, the H. H. Rogers road. The train consisted of 120 steel coal hoppers, each 44 feet long and each loaded with 50 tons of coal. A Mallet compound engine, a tender and caboose made up the rest of the train. The train from cowcatcher to caboose was 6 feet more than a mile long and the coal was valued at $18,000.

SUBJECTS UNDER DISCUSSION :-: :-:

Comment, criticism and debate upon various articles, letters and editorials which have appeared in previous issues

Load Factor

I was very pleased to read the editorial on "Load Factor" in POWER of November 9. As there expressed, the term "load factor" should be used to express the ratio of the actual output of a plant to what would be the output if the plant ran continuously at its full-rated capacity. In Great Britain, however, the term is not generally so used, but is employed to express the ratio between the actual output and what would have been the output if the plant had run continuously at the maximum load which it ever carried. The ratio which I have said ought to be expressed by the term "load factor" is sometimes referred to under the term "plant load factor," and I have myself used this expression, but I do not think it can be said to be generally accepted. Something might be gained by a discussion on the subject in the columns of POWER. Uniformity in the employment of technical phrases on both sides of the Atlantic is very desirable.

R. M. NEILSON.

Glasgow, Scotland.

Real Relation of CO_2 to Chimney Losses

I have read with great interest Mr. Hays' criticism of the original article with the above heading which appeared in POWER of June 8. Some of his criticisms are well made, but he has made quite a few statements which, on further thought, he would undoubtedly regret. I agree with him that the CO_2 determination is a good thing to have and I stated so very distinctly in my original article. The object of the article was to show just where the CO_2 determination when used *alone* would lead to error. In the latter part of Mr. Hays' criticism he asks why I did not take the flue temperatures as they actually were and tries to show how all my calculations were wrong because I assumed the flue temperatures to be the same—viz., 600 degrees Fahrenheit. As a matter of fact the highest flue temperature accompanied the highest percentage of CO_2 and this would add to the losses with the higher CO_2, making a point in my favor. He refuses to consider the tests as given because the percentages of methane and illuminants were not given. His remark is only too true about the great loss which would be incurred by a very small amount of methane in the flue gas; but when he says that the figures are all wrong because this determination is lacking, I think he is making a very rash statement. While the determination of methane is rather tedious, the determinations of CO and O are no more difficult than that of CO_2. The apparatus is the same and the only difference is that a little longer time is required. About five minutes will suffice to complete the absorption of either with good apparatus and fresh solutions. Also if fresh solutions are used, no fear need be felt about the inaccuracy of these determinations. Even the potash solution used for absorbing CO_2 has to be renewed occasionally.

Mr. Hays criticizes my calling the "volatile combustible" matter by this name. This is the usual practice, but the question as to whether it is a misnomer is debatable, not by engineers but by chemists. As a matter of fact, just because a compound contains oxygen and hydrogen, it cannot be said that they exist as "water of constitution," which means water that is in a compound as water and can be removed as water without destroying the compound itself. It is true that the oxygen has no heating value, but whether it exists as water of constitution remains to be proven. I am inclined to think that the oxygen exists as the (OH) or hydroxyl group as it does in alcohol and other oxygen organic compounds. This group has a heating value but not very great. A discussion of this does not belong here, however.

As for the nitrogen, it also must exist in combination and in nearly every instance where elements exist in combination their heating value is changed. I might say here that every element which can be oxidized has a heating value and this includes all of them but two or three.

Even if I admit that the hydrogen and oxygen exist as water of constitution, no error is introduced by using them as I did. What is gained on one side is lost on the other.

Speaking about the SO_2 from the sulphur, it may be well to state that the sulphur in this coal (dry) was 0.63 per cent. There are coals (Western) where the sulphur content is as high as 7 per cent. My error was from 0.13 to 0.16 per cent., but multiplying this by 11 to come near the higher sulphur, we have an error of from 1.43 to 1.76 per cent. It is easy for any engineer to see what it would be for his coal if he knows the sulphur content by comparing with the tests as given. While it is true that the analyses of flue gas cannot be absolute, it is well to know where the chances for error are.

The words used by Mr. Hays in speaking of the St. Louis tests were rather surprising. I consider these tests of the highest value, because they were conducted by experts who were after the truth and not to show a high economy in favor of some special boiler-house appliance. Unbiased tests and opinions are always valuable.

I have already admitted that the case of 2.1 per cent. CO was extreme, and Mr. Hays is correct in thinking that I picked out the worst one I could find in the whole test. However, there were quite a few times in various tests where the CO ran up to 1 per cent. and the bulletins are available to anyone who wishes to see for himself. However, this test is given and we have no reason for actually believing it is wrong because it is high, and I again raise the question: How do you know you are not getting it? You do not and will not unless you analyze your gas. Mr. Hays says that you can fix the fire so as to get most any gas you want. I presume he means CO_2 alone, for no man can fix a fire so as to get any certain proportion of CO_2, O, CO and nitrogen. Where you depend on one ingredient alone, the others have to come according to conditions.

I admit that a snap sample is of relatively no importance. The tests must be made at regular intervals. Why cannot some of the manufacturers of CO_2 recorders make an oxygen and CO recorder? It would not be as difficult as it seems if they were demanded by engineers.

In his last paragraph Mr. Hays implies that all the calculations which I made were theoretical and attempts to bluff the engineer, who cannot figure it out for himself, into thinking that the CO_2 alone is good enough for anyone who is practical, and the remainder is to be left to the "experts" who sit in the offices and tell you how to do it. He almost

puts me in that latter class. I would say that in my opinion, the determination of CO_2 in flue gas is about as good an indication of the economy as the determination of the fixed carbon is of the heating value. In both cases they are general, but in neither case are they reliable when used *alone*.

There are some interesting statements made in the Geological Survey booklet, No. 325, which should be mentioned here. I will quote from page 64 of the above, speaking about the "Unaccounted for" in the heat balance.

"The important point in this discussion is that low efficiency is always accompanied by the highest per cent. of CO in the flue-gas analysis, and the highest efficiency by the lowest per cent. of CO. Moreover, the high CO values always go with the highest combustion-chamber temperatures. It is also found that as the combustion-chamber temperature increases, the per cent. of black smoke increases.

It is not possible to account for very much loss in burning coal by the amount of CO found in the gas analysis. Therefore it seems that this appearance of CO in the gas analysis is indicative of bad conditions such as an irregular fuel bed or the escape of hydrocarbons unburned."

This paragraph gives the whole thing in a few words. This conclusion was drawn, not from one test or from 78 tests, but after a careful study of 400 tests. This bulletin has numerous relative data derived from the 400 tests and many are plotted. I would advise every reader as well as Mr. Hays to get one of these bulletins (they cost only 20 cents from the Superintendent of Documents at Washington, D. C.) and refer to Figs. 14, 17, 18 and 19.

Fig. 14 shows the relation of the combustion-chamber temperature to the CO_2, O and CO. It is well to note that while high temperature accompanies high CO_2 it also accompanies high CO. Fig. 17 shows similar results with CO_2 alone. Fig. 18 shows the relation of the per cent. of CO_2, O and CO to efficiency *72 as figured in the American Society of Mechanical Engineer's code. The CO_2 curve is particularly interesting since it approaches a straight horizontal line at about 12 per cent. CO_2, which means that no further efficiency is gained above 12 per cent. CO_2. This curve was derived from 312 tests. Fig. 19 shows the relation of CO to efficiency *72 and needs no comment. Fig. 31 shows the relation of completeness of combustion to the percentage of CO_2. As the CO_2 goes above 8 per cent., the combustion falls off very rapidly (that is, percentage of completeness). This explains why high CO_2 percentages are not absolutely the most economical. Another fact adds to the losses with high CO_2 percentages. High CO_2 means high combustion-chamber temperature. I will quote again from Bulletin No. 325 on page 100. Speaking of the effect of high initial temperature on economy it says:

"The loss up the stack is not reduced so much as the reduction of the weight of gases per pound 'combustible' would indicate, because with rise of the initial temperature the flue-gas temperature rises also."

On page 101 of this bulletin they arrive at conclusions and figures of exactly the same kind as mine, viz., a high CO_2 can be accompanied by a much greater loss than a lower one. My figures were based on an actual test; theirs on a calculated test.

Mr. Hays' opinion and mine are exactly opposite and I would advise no man to take any one man's opinion as an absolute law. If the engineer who is in doubt will make some figures for himself or examine the number of excellent engineering bulletins put out by the Geological Survey as well as by some engineering universities, he can form his own opinion. I would say to a fireman, "Get as high CO_2 as possible without getting any CO, hydrocarbons or smoke." This would possibly give a high economy, especially if the flue temperature were kept down, but as for running a boiler plant with CO_2 determinations *alone* (without flue temperatures, water meters, etc.), I would consider it rather a doubtful method.

JAMES E. STEELY.

Covington, Va.

Writing for Catalogs

With reference to Mr. Oakley's remarks in the December 14 issue regarding the sending for catalogs, it may be of interest to state, that a business house which spends considerable money exploiting its products naturally does not like to see any of its money wasted. When anyone writes in for a catalog, and particulars regarding a business proposition, the attention required to answer his request means the expenditure of some time and money. No manufacturer can therefore be wholly blamed if he wishes to be convinced that his literature is falling into proper hands. Where a man is ambitious and shows a decided intention of advancing himself and puts the matter in a straightforward business way, it is doubtful if any business concern would fail to send such a man the information requested, because a man who is industrious is bound to advance sooner or later, and modern business houses value future business as well as present business.

No opportunity for business, no matter how remote, is overlooked in these days.

Business is harder to get; there is more and more competition, and if any man, who is a future possible user, writes in for a catalog, most firms will, I think, be only too glad to send him a copy. The concerns that send such a man the information that will help him to advance, will be pretty sure to be remembered when he is in a position to reciprocate. An established business house will always think twice before they refuse a reasonable request of this kind.

I believe if a man has the right idea about sending for catalogs, and really means to benefit by the literature he receives, he is bound to be influenced more or less in favor of the goods he studies about, and need feel no regret about having caused any trouble to the sender. Later on he will be sure to remember where he got his help from, and then the sender will in most cases be more than repaid.

L. W. KEELER.

New York City.

Does a Suction Head Help a Condenser?

In the November 23 number, Mr. Thompson asks: "Does a Suction Head Help a Condenser?" I think the only difference in the cost of running the condenser would be the cost of elevating the water to a point above it.

If there is the same size of gate in the inlet pipe in each case, and if it required the gate to be wide open to supply the condenser in the case of the 10-foot lift, then it would be necessary partly to close the gate in the case of the 10-foot head. Having the water above would help in starting the engine, as it would not be necessary to prime the condenser. This is worth something.

Where I work, we take part of the water supply for the condensers from wells and part from a concrete pond which is a little above the condenser. The water is discharged back into the pond; the discharge pipe runs to the far end where it sprays the water up for cooling. The cost of elevating the water in this way is very slight.

J. E. ESTES.

Ponemah, Ill.

I would say that it does not help the condenser any to have the water come to it under a head, as the supply must be throttled by the valve in the suction pipe or the water would flow in so fast there would be no vacuum. It will need to be throttled pretty well on even the 10-foot lift, as a vacuum of 26 inches will lift water more than 20 feet. This question is similar to one asked of an applicant for an engineer's license a short time ago. He was asked if it put any more work on a condenser pump to lift water 20 feet than it did to lift

it 12 feet. He replied that he thought it did. He did not get a license.

C. B. SMITH.

So. Framingham, Mass.

The power required to operate the condenser will be the same in either case. In the first case with the supply 10 feet above the regulating valve the total pressure tending to force the water through the valve will be 17½ pounds, with a 26-inch vacuum on the condenser (13 pounds due to the "pull" of the vacuum, and about 4½ pounds due to the 10-foot column of water above the valve). In the other case with the water 10 feet below the regulating valve, the "pull" of the vacuum will be equal to 13 pounds, from which must be subtracted the 4½ pounds required to lift the water 10 feet. This leaves 8½ pounds, which is the pressure tending to force the water through the regulating valve. As the amount of water required is the same in either case, the water flowing to the condenser with a head of 10 feet must be throttled considerably more than the water requiring a 10-foot lift. It is this throttling which consumes the surplus energy.

It would be a dangerous arrangement to have the water flow to the condenser under a head unless some provisions were made for automatically shutting off the flow in case the vacuum failed while the engine was in operation, as the water, being under pressure, would continue to flow and would be liable to damage the engine by backing up into the cylinder through the exhaust pipe.

S. KIRLIN.

New York, N. Y.

Elimination of Oil from Condensed Steam

The recent article in POWER by Geo. H. Gibson relating to the elimination of oil from condensed steam has stated the facts of this important subject in a very clear and interesting manner, giving the true cause of the difficulty heretofore found in thoroughly and completely removing the last particles of oil from the cloudy and emulsified water. This difficulty, as Mr. Gibson stated, has been owing to the extreme minuteness of the oil globules found in the emulsified or cloudy-looking condensate, and which may be as small as one-one-hundred-thousandth inch in diameter, defying all attempts to remove them by any heretofore known filtering medium such as turkish toweling, terry cloth, sand or other permeable substance. It will therefore be interesting to readers, and steam users in general to know that a newly discovered process has lately been put into practical operation, which is based upon the energetic absorptive power, or physical attraction which some natural magnesium silicates have for oil or grease, as discovered by the writer some years ago.

These absorbents consist mainly of the pulverized rock from serpentine quarries, found in various parts of the United States and Canada, which is mixed with a certain proportion of sand to increase the surface contact with the condensation water while the latter is passing through a bed of the mixture, so that the smallest emulsified oil particles are immediately absorbed and held back, rendering the water clear and free from the last traces of oil or grease, and as bright as any sparkling spring water or distilled water. The amount of oil which this fibrous serpentine will absorb is very large, often more than 50 per cent. of its weight, and the tenacity with which the oil will be retained within the absorbent is such that it can be removed only by means of benzine, gasolene or other similar solvent, boiling water or steam having very little effect thereon. The apparatus used in working this process is almost the same as that of an ordinary pressure filter, except for the special connections necessary for stirring up the absorbent mixture from time to time. There is no skilled labor or expert attendance required and no danger in using an excess of the mixture such as there would be in chemical coagulation. The cost of the material is very reasonable, consisting mainly in freight charges to the various localities where required. The thickness of the bed of absorbent material may be from 6 inches to 6 feet or more if necessary, depending upon the pressure available, and the filters may be adapted for either land or marine use.

As an evidence that the purifying action of the fibrous serpentine is not a filtering one it may be stated that when pulverized, one part of the substance in 2000 parts of average emulsified water will clarify the latter by simply shaking or violently stirring, or boiling up the contents of the vessel. After standing half a minute the water will be found entirely clear and free from oil. At the works of Alex. Miller & Brothers, Jersey City, where it has been in successful operation over six months, this process may be seen and inspected at any time. Wherever the above-described absorbent serpentine process is used it is of course, also desirable to first remove the free or coarse oil by means of skimming tanks or ordinary terry-cloth filters so as to utilize the absorbent serpentine in the most economical manner, leaving the latter to remove the milky or cloudy appearance of the condensate which the terry cloth or Turkish toweling is incapable of filtering. The separator in the exhaust mains should also be retained in any case as stated by Mr. Gibson, but not because they could ever be depended on to remove sufficient oil from the steam to make the latter safe as a feed water after condensation (which they can never do) but to keep as much oil as possible out of the condenser and the hot well so that the subsequent removal of all of the oil from the main condensed water will be made simpler.

A great drawback about chemical coagulation is the expert attendance necessary to prevent too much or too little of the reagents being introduced into the water. Unless the proper and exact proportions are used to meet the varying quantities of emulsified oil in the condensation the resulting water will retain too much soluble and detrimental matter in solution or there will not be sufficient precipitation to remove all of the emulsified oil. The absorbent serpentine process here described, being of a non-chemical nature, an excess of clarifying material used can have no detrimental effect as the material is practically insoluble. All expert chemical attendance is therefore unnecessary, and the cost of working consequently nominal. By this absorbent process furthermore all the drip can be saved as well and readily as the regular condensation, so that there is no waste of water whatever except the small amount lost by leakage or evaporation. Careful and frequent analysis of condensation water clarified by the herein described absorbent filtration process have shown a total absence of oil or grease and a mineral residue in solution of but two to three parts per 100,000 consisting mainly of magnesium carbonate, a light harmless substance which has no tendency to form scale and only about sufficient in amount to neutralize any fatty acids that may have been produced by the partial decomposition of some of the lubricating oil in the condensed water.

In the removal of oil from condensation or from steam the essential requirement is to remove *all* of the oil not *nearly* all or not even 99.9 per cent., as is frequently stated in trade publications. Unless the remaining one-tenth of one per cent. is also removed there will still be oil enough left to leave the water dangerous to use for boiler feed. This fraction of a per cent. of oil remaining in the steam is plainly visible in the subsequent condensation, giving the latter that milky opalescent appearance mentioned in Mr. Gibson's article, which is always indicative of oil or grease, no matter how often it may have been filtered through terry cloth, excelsior, Turkish toweling or any other simple filtering material, and the water if used in this condition will be certain sooner or later to show the usual evil results in boilers, particularly in those of the water-tube type.

Concerning the influence of even small

amounts of grease such as may be found in milky-looking or opalescent condensation, the following may be instructive and serve as a warning against the use of such water for boiler feed. Messrs. Strohmeyer and Barron, in a paper before the Institute of Naval Architects in Manchester, on "Distortion in Boilers due to Overheating," state that the peculiarity of grease deposits in boilers is that their effect is out of all proportion to their thickness.

Scale ⅛ of an inch in thickness will raise the temperature of furnace plates 300 degrees Fahrenheit. As grease offers ten times more resistance to heat, one would think that 1/80 of an inch would have the same effect as this thickness of scale, but experience shows that the merest trace of grease, certainly less than one-thousandth of an inch, or one-tenth of the above, can cause far more serious injury than scale. It also follows from the above statement that a boiler containing the slightest film of grease on its inner surfaces must have a greatly diminished efficiency as a steam producer. In any case it is highly desirable to remove every trace of grease from the feed water. Where scale also is present the effects of the grease are intensified.

As above stated this emulsified oil could not be removed by any of the filters heretofore on the market; the most that the latter could do was to remove the coarse or free oil which will readily rise to the surface of the water and can then be skimmed off. Your correspondent, John S. Kirk, in the October number of POWER also emphasizes this clearly by stating that "no amount of filtering which is practicable in all ordinary steam-power plants will separate this emulsion into its elements of water and oil. They go to the boiler together, and while the water is made into steam the oil is left behind to stick to the tubes and shells and make all kinds of trouble." It is also a well known fact that grease separators in the exhaust-steam pipe although efficient for removing a very large proportion, particularly when new, do not remove the last traces of grease.

In the opinion of a great many practical men who have from time to time examined the absorbent serpentine process for removing the last traces of oil from condensation feed water as herein described, this problem is finally and practically solved, and should be of great and particular interest to those who now hesitate about installing surface condensers, owing to the impossibility heretofore of totally removing the oil from the condensation when used for boiler feed, as well as to those who have had costly experience resulting from oily feed water.

ARTHUR E. KRAUSE.

Jersey City, N. J.

Flywheel Explosion at Scranton

In regard to the flywheel explosion at Scranton, I would say that if the generators were direct-current machines the engine in question would not have had to be out of order to produce the result. Some years ago, at Columbus, O., I had an old style Corliss of about 300 horsepower, running with a lot of other generators and rotary converters on a railroad load. One day, this machine was "grabbed" by the others and in about one second was speeded up until the reach rod jumped off. All that saved the engine was the letting go of a heavy gasket in an exhaust bonnet and the release of the circuit breaker. In this case the equalizers were connected to the negative side, so the generator was not supposed to reverse.

I know of another case in which the equalizers were connected to the positive side of the generator, where the generator reversed and started the engine backward against a pressure of 145 pounds of steam at the throttle. Something like this may have happened at Scranton, especially as turbines are susceptible to heavy overloads. When the engine started the governor may have risen a little easier than the operator figured it would.

JOHN W. COOVER.

Seattle, Wash.

Engineers' Wages

The question of "Engineers' Wages" will require a better pen than mine to bring it before the men who pay the wages, in language sufficiently strong to produce any effect.

It is against the law for a man to operate a steam boiler in Massachusetts without a license. In most cases the beginner must work as a coal passer for a year before he is able to show enough experience on his application blank to be examined for his first license. At this work, his rate of pay is about 17 cents per hour.

If he gets his license he is able to take a position as fireman. His pay now will be a little better than 20 cents an hour for a twelve-hour day. By the time he has fired a year and studied in the mean time, he can take his examination for a third-class license. No examiner will give a man more than one license within a year, which is perfectly right.

After he has received his third-class license, he is one rung higher on the ladder but not much better off as far as wages go. However, at this stage experience is worth considerable and his third-class license will give him a chance to get into a large plant as an assistant.

If he is able to get his second-class license after another year he is a pretty smart boy. To get this license he must understand hydraulics and possibly cold storage, and be a fair mathematician. When he gets his second-class license he can hold down a 150-horsepower position and must be a steamfitter, electrician and something of a machinist. This kind of an engineer usually commands $3 per day.

The first-class man usually has to have five years' experience before he is able to pass a first-class examination, and he must be able to tell how to design or build most any piece of machinery in a steam plant. His wages average from $3.50 to $4 a day. He is a man who must always be working, can never take any rest and is responsible for thousands of dollars worth of property day and night. The foreman of the shop next to the engine room is probably getting $5 per day and working regular hours. When his day's work is done he has nothing to think of until the next day.

A short time ago they were paying the hod carrier 45 cents an hour in this State and he only worked eight hours per day for his $4. Think of that, a man who need not be able even to write his name, getting more pay than the second-class engineer.

L. W. CHADWICK.

Bridgewater, Mass.

Would like to say a few words concerning the editorial "Engineers' Wages" which appeared in a recent issue of POWER. I think the question of engineers' working hours is equally important. When I first entered the practical electrical-engineering field, I was surprised to learn that the body of intelligent men engaged therein were working twelve hours a day and seven days a week. This condition of affairs results from the fact that they are not organized. It is a fact that bricklayers are paid more for working forty-eight hours a week than practical electrical engineers are paid for working eighty-four hours a week.

Think this matter over, brother engineers, and ask yourself why you are working twelve hours a day when printers, carpenters, machinists and men in other trades too numerous to mention are working only eight hours. Surely the country is no more dependent upon the printer or the carpenter than it is upon the electrical engineer. I would like very much to read the opinions of other electrical engineers on this subject.

FRANK WELLS.

Savannah, Ga.

Cylinder Lubrication

We have in our plant, a 12 and 23 by 36-inch Nordberg-Corliss engine making 116 revolutions per minute, 24 hours a day for 365 days a year; a 13x12-inch vertical engine averaging 75 revolutions per minute for 24 hours a day, when it runs; a 12x16-inch air compressor averaging 50 revolutions per minute and running about 18 hours a day, and a 6 and 4 by 6-inch duplex boiler-feed pump.

In the Corliss cylinders, we have used 10 gallons of oil per month for the last four months. This is about two-thirds of a quart in each cylinder every 24 hours.

The last consecutive run of the vertical engine was for 31 days. During this time, we used one gallon of oil. This is about a quarter of a pint every 24 hours.

The compressor will not do its work without oil in the cylinder. We used four gallons a month or about a pint every 18 hours.

In the pump cylinders we use about a gallon of oil a month.

Our engines were designed to operate under 150 pounds steam pressure but as they are never required to develop full capacity and as steam economy is of no consideration, for we get our steam free of cost, we operate at only 100 pounds. The boilers are 500 feet away from the engines, so we have wet steam. Our cylinders and valves are all in good condition.

I notice that some engineers describe their oil consumption as so many drops per minute. I believe they should be more explicit, for in my experience I have found that some oils will run away faster at the rate of one drop a minute than others will at six. Then again, the same oil may flow away more quickly through water at the rate of two drops a minute than it will through glycerin at six drops. We use a heavy oil costing 35½ cents a gallon.

F. W. BAIR.

Hancock, Mich.

I think that cylinder lubrication is too much a matter of habit with too many engineers. The lubricator is set to feed a certain number of drops, and if no trouble is experienced it is not changed, while safe and satisfactory operation might be had on 50 per cent. less oil.

I cut down the feed on a 14x15-inch Atlas four-valve engine running at 200 revolutions per minute from two gallons to about three pints in a 12-hour run. This engine is fitted with a force-feed lubricator having three pumps, one running to the main steam line at the steam chest, and the other two to the exhaust valves. This lubricator was set for a good strong stroke and the same on all pumps. Whenever I had occasion to run this engine I shut off the feed to the exhaust valves, and at no time did we notice any difference. I next reduced the stroke on the pump feeding into the steam supply to a very small travel, and noticed a great reduction in the amount of oil used, but the lubrication of the engine is satisfactory in every way and I have been running on this amount for the past year.

I also have a 14x36-inch Corliss engine running at 100 revolutions per minute and pulling from 100 to 175 horsepower. This engine is fitted with a one-quart lubricator, which is set to feed one drop for each 30 revolutions.

The average boiler-feed pump is very wasteful of cylinder oil, as they run with very low piston speed, and it is very easy to feed too much oil. I have cut down the feed to one-quarter of the usual amount, and experienced no difference in the action of the pump.

I consider the proper method to connect any lubricator is to run the oil pipe into the steam line far enough to get the spray effect, and not let it run down along the side of the pipe where it will not be affected by the draft of the steam.

I do not consider that the load makes much difference as to the amount of oil required as the only change in the cylinder mechanism is a little longer travel in the valves.

I have a brother who is now in his sixth year as engineer in the United States navy. He has been much interested in the action of running cylinders without oil, and his experiences have extended over a good many ships, but in no case does the absence of oil appear to cause any trouble. Some of these ships are fitted with the largest engines in existence, and use the highest pressure steam, the engines getting it quite highly superheated. I would not expect to get results from horizontal engines without some oil.

G. S. SPRAGUE.

Geneva, Neb.

Kerosene in Boilers

Having read a great deal pro and con regarding the use of kerosene oil in boilers, and having noticed that very little has been said about the reason for success or failure, an explanation of the action of kerosene on scale may prove useful as well as interesting.

Some scale that forms in boilers is more or less porous, and is, therefore, capable of absorbing liquids like water or kerosene. If the boiler is wet, the pores in the scale will probably be full of water; and if oil is put in, very little will be absorbed. If the boiler is dry when the oil is put in, the scale will absorb considerable quantities of the kerosene. The ideal way of getting the oil into the scale would be to throw it around on the dry scale inside the boiler until the scale had absorbed all it would hold. But this cannot always be done, so the next best way is to run some oil into the cold, dry boiler and gradually add water until full. The oil floats on the water and reaches the scale before the water does. Consequently much of the oil will be absorbed along with the water, and the slower the water is run in the more oil will be absorbed.

Water, when heated, gives off steam. In the same way, kerosene oil, when heated, gives off a gas. For the poorer grades of oil enough gas is given off, when the oil is heated to 110 degrees Fahrenheit, to burn in the air if lighted with a match; for the better grade of oil the temperature for this "flash point" will be up toward 150 degrees Fahrenheit.

Now, the temperature of boiling water is 212 degrees Fahrenheit, and as the pressure in the boiler increases the temperature gets much higher. Suppose we feed kerosene into the boiler when getting up steam. Then the oil quickly forms a gas and passes out with the steam. Very little, if any, ever touches the scale, and consequently we can't expect it to effect the scale.

When the oil is put in the wet boiler and floats on the water when getting up steam much the same thing happens, as very little oil ever really gets into the scale. But suppose the oil has had a chance to soak into the dry scale and fill every pore before commencing to steam up. Then as the boiler gets hot some of the oil becomes a gas; and, as it gets hotter, more gas is formed. This gas needs more room than the oil occupied, so it expands and pushes out of the little pores and breaks the particles of scale apart in its effort to get free.

When the boiler is cooled down and opened up we would expect to find the scale all cracked loose, and this is exactly what happens. The scale must be taken from the boiler at this time, or the blanket of scale on the bottom may allow the metal to become too hot and "bagging" may result.

Therefore, the essential thing is to get the oil directly into contact with the scale. The oil is not a solvent by any means—it merely acts in the pores of the scales like dynamite in a hole in a rock when blasting.

Hence, we see that kerosene fed into the boiler with the feed water cannot prevent scale forming, nor remove any already there. But oil that really gets into the scale and is then heated loosens the scale by cracking. This explains why some engineers claim great value for oil as a boiler cleaner, and others, just as honestly, claim it to be worthless. Think it over and then try it for yourself.

L. P. HORSFALL.

Watertown, Mass.

Storing the Energy of Exhaust Steam

Need of Regenerator to Smooth out Variations between the Momentary Discharges of Engine and Demand of Turbine

It has been previously demonstrated in these columns that in expanding steam adiabatically to a range of pressure from 150 pounds gage to 28 inches vacuum practically one-half of the energy which can be converted into useful work is available below atmospheric pressure. Thus when engines exhaust to atmosphere nearly half of the available energy in the steam is thrown away.

To illustrate this point consider a pound of saturated steam at 150 pounds pressure per square inch by gage, or about 165 pounds absolute. Its volume is 2.75 cubic feet, its temperature 366 degrees Fahrenheit and its heat content above water at 32 degrees Fahrenheit is 1194.7 B.t.u. The pound of steam is expanded adiabatically—that is, without receiving heat from or giving up heat to any external body—down to atmospheric pressure, it will occupy 23.13 cubic feet, will have a temperature of 212 degrees Fahrenheit and will still contain 1018 B.t.u. Upon further adiabatic expansion down to a vacuum of 28 inches of mercury, referred to a 30-inch barometer, this expansion is easily obtainable with modern condensers. The volume of the original pound of steam will be 263.9 cubic feet, its temperature 101 degrees Fahrenheit and the total heat contained, which must be rejected to the condenser, 869.7 B.t.u. For a perfect engine, working between 150 pounds gage and atmospheric pressure, it is thus possible to convert into work 176.7 B.t.u., while that available between atmospheric pressure and a 48-inch vacuum is 148.3 B.t.u.

It has been found that a compound noncondensing reciprocating engine will convert about 65 per cent. of the available energy of the steam into useful work, while if additional cylinders are added, that is, making the engine a triple- or quadruple-compound, only about 40 per cent. efficiency can be obtained in the range below atmosphere. On the other hand a low-pressure steam turbine easily shows an efficiency of 80 per cent. in working from atmospheric pressure down to a 28-inch vacuum. Reciprocating engines show high efficiencies worked to the higher range of steam pressure, while on the other hand the steam turbine is adapted to handling large volumes of steam at low velocity and shows high efficiency when working under low pressures, as from atmospheric pressure down to 28 inches vacuum. It would thus seem that a combination of the reciprocating engine and the steam turbine would present the ideal arrangement for obtaining a maximum amount of work from each pound of steam.

Steam plants now using reciprocating engines either condensing or noncondensing, can, in the majority of cases, add an exhaust-steam turbine to the present equipment and increase the power output from 60 to 100 per cent. without further investment in boilers, chimneys or housings, and since no more live steam is used, the coal consumption will not be increased. The chief difficulty, however, lies in the fact that the exhaust from the reciprocating engine is intermittent, while the steam turbine should have a constant pressure at this first stage. When the two units are carrying separate loads, it frequently happens that the reciprocating engine at one moment discharges a larger volume of steam than the turbine can use, and at the next moment an overload occurring on the turbine, there would not be enough steam exhausted from the reciprocating engine to enable the turbine to meet its load. It will thus be seen that to use a combination of reciprocating engine and steam turbine it is advantageous to have some sort of a steam-storage arrangement which can absorb the excess exhaust steam of one moment and carry it over to make up the deficiency of the next. Such storage is provided for by the apparatus shown in Fig. 1, which is known as the American regenerator and was recently placed on the market by the American Regenerator Company of Chicago.

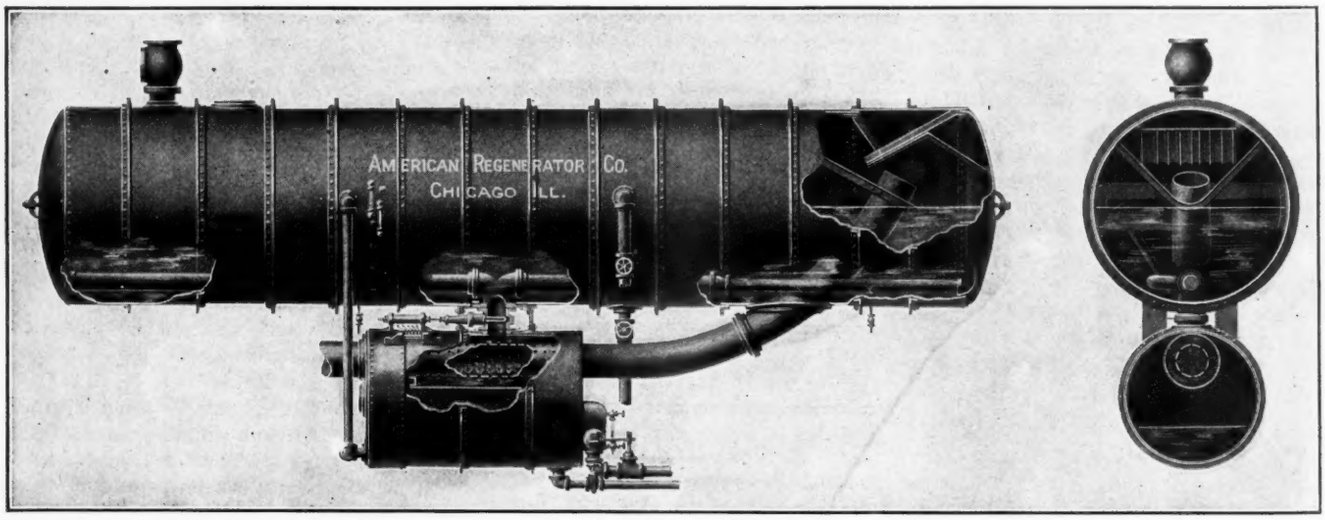


FIG. 1. SIDE AND END SECTIONAL VIEW OF AMERICAN REGENERATOR

When more steam is delivered to this receiver or regenerator, as it is called, by the engine than is withdrawn by the turbine, the vapor pressure, and therefore the vapor temperature, rises, whereupon some of the steam gives up its heat to the water in the receiver, causing condensation. Again, when the steam withdrawn by the turbine is greater than the supply of steam given by the engine, the pressure in the receiver falls and

the water which has been previously heated gives up some of its heat, thereby reëvaporating a certain amount of water and supplying the deficiency of steam. The amount of heat storage is limited by the range of rise and fall of temperature of the heat-giving medium. If it is desired to maintain the pressure in the receiver within the limits of 15 pounds and 18 pounds absolute, the temperature range will be from 213 to 222.4 degrees Fahrenheit, and each pound of water heated and cooled throughout this range will store up and release 9.4 B.t.u.

Referring to Fig. 1, the water from the larger tank falls through a pipe, containing a valve, into an annular space surrounding the perforated spray pipe through which the exhaust steam from the engine enters. In entering the lower chamber the exhaust steam operates a vane which in turn controls a valve in the pipe connecting the upper and lower chambers. Thus the amount of water supplied to the outside of the spray pipe is always proportional to the amount of exhaust steam passing through it. In this manner the steam comes into thorough contact with the water which as a consequence is heated up to the full temperature of the steam. The momentum of the steam is sufficient to carry the mixture of water and steam up through the eduction pipe into the upper tank, where the mixture is delivered against suitable baffles and separated from the steam.

With the arrangement shown in the illustration the coldest water, which is naturally at the bottom of the large tank, is intimately mixed with the exhaust steam and returns to the surface of the water, inducing good circulation and mixture of water and steam.

As apparent in Fig. 1, the water level is maintained at about the center of the tank. This gives a shallow depth of water, so that the steam may be readily disengaged during operation, and presents the maximum surface for the disengagement. It should be borne in mind that the hydraulic head of a body of water influences the speed of evaporation. The increase in temperature required for the liberation of steam is one degree Fahrenheit for each 8 inches depth of water. Given sufficient time the warmer water would, of course, come to the surface by gravity circulation and liberate its steam, but in the apparatus under description time is one of the principal elements.

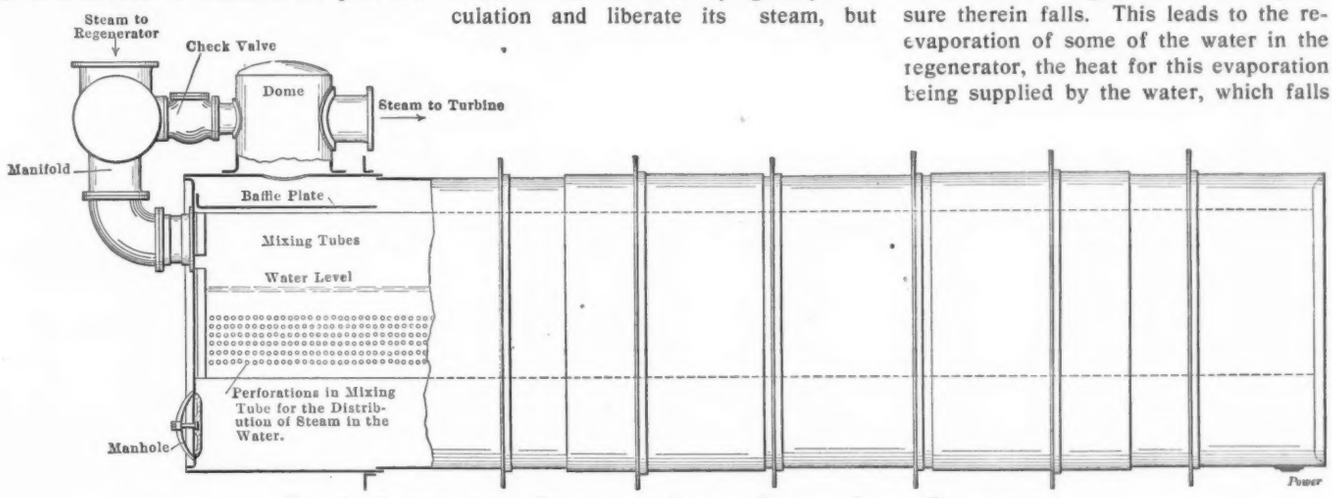


FIG. 2. LONGITUDINAL SECTION OF RATEAU PATENT STEAM REGENERATOR

Another type of regenerator is shown in Fig. 2. The internal construction appears to better advantage in Fig. 3, and in Fig. 4 a view of the regenerator being assembled is shown. In this apparatus the exhaust steam enters the mixing tubes through the manifold shown at the left in Fig. 2. The mixing tubes extend the full length of the regenerator above the water level and have a contracted portion projecting below the water level, perforated with a large number of small holes. Steam is discharged through the small holes and passes upward through the water in small bubbles, thus giving an enormous surface of contact between the steam and water. The upward motion of the steam keeps the water in circulation around the vertical baffle plates, as shown by the drawing in Fig. 3.

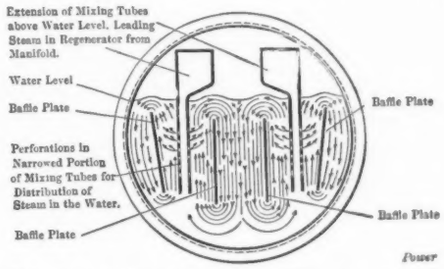

Extension of Mixing Tubes above Water Level, Leading Steam in Regenerator from Manifold.
Water Level
Baffle Plate
Perforations in Narrowed Portion of Mixing Tubes for Distribution of Steam in the Water.
Baffle Plate
Baffle Plate
Baffle Plate
Power

FIG. 3. ARRANGEMENT OF MIXING TUBES AND BAFFLE IN RATEAU REGENERATOR

The apparatus illustrated in the last three figures is one of the numerous types designed and patented by the Rateau Steam Regenerator Company, of New York City, and is especially adapted to equalize the exhaust steam of milling engines, hoisting engines and steam hammers.

It may be of interest to consider what happens when there is not sufficient supply of exhaust steam to supply the demand of the turbine. If the engine is shut down entirely, the turbine draws steam from the regenerator and the pressure therein falls. This leads to the reevaporation of some of the water in the regenerator, the heat for this evaporation being supplied by the water, which falls in temperature. To supply one pound of steam at 15 pounds absolute pressure requires 965.6 heat units, and if the total range in pressure is from 15 to 18 pounds and from 213 to 222.4 degrees in temperature, each pound of water will restore 9.4 B.t.u. To supply 965.6 B.t.u. to evaporate one pound of steam, the tank should hold 103 pounds of water for each pound of steam to be supplied to the turbine during the period of regeneration. The pressure at which the regeneration is operated can be varied to suit requirements, but it will usually be found advisable to operate at or above atmospheric pressure in order to forestall air leaks, as air is highly detrimental to the vacuum in the condenser.

Obviously the size of the regenerator will be determined not only by the amount of exhaust steam supplied by the engine and by the size of the turbine, but also by the length of the time interval during which the regenerator must supply steam to the turbine.

In some cases the regenerator will have to furnish all the steam during certain periods of time, as in the case of reversing rolling-mill engines, hoisting engines, steam hammers, etc., which stop altogether. In a large number of plants, however, the supply of steam does not cease entirely, but only fluctuates, that is, there are peaks and valleys in the load curve. Supposing that the turbine load is constant and that all the exhaust steam is to be utilized, these peaks must be carried over to fill up the valleys, and the size of the regenerator will be determined by the magnitude and duration of the load fluctuations.

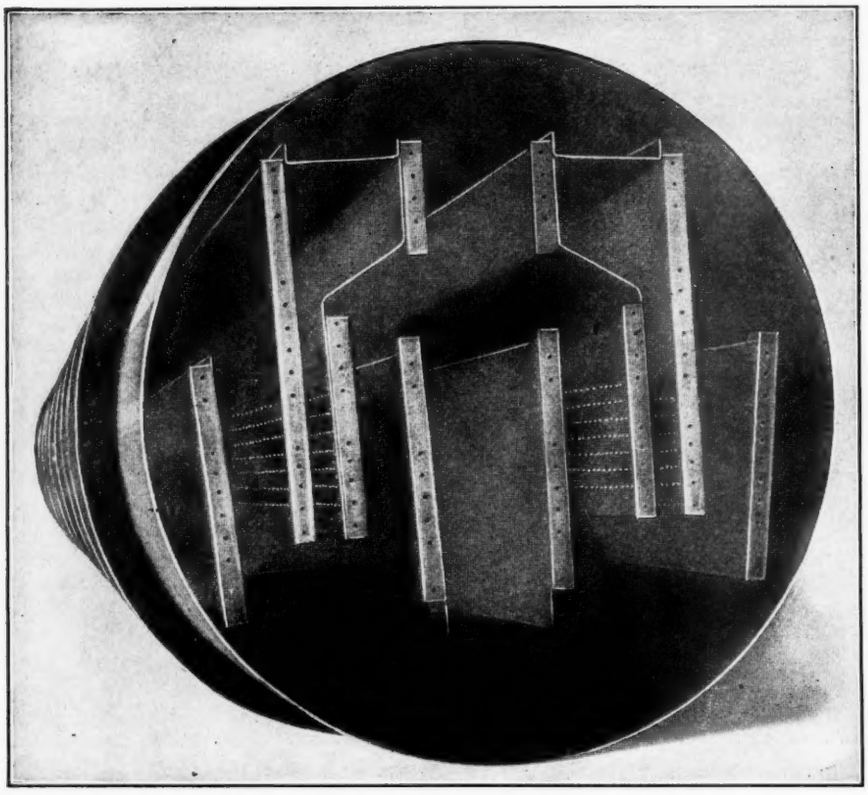


FIG. 4. RATEAU REGENERATOR UNDER CONSTRUCTION

It is not desirable to provide storage for too long a period, since if the main engines are stopped for any considerable time, the boilers will soon begin to blow off and it will be as well to use this blowoff steam directly in the turbine through a reducing valve, or on the high-pressure stage of a mixed-flow turbine, rather than to provide sufficient regenerator capacity to carry the turbine over a long period of time.

The several combinations in which it is desirable to have a regenerator might be noted as follows:

First, where the output of steam by the engine is intermittent or fluctuating and the requirements for steam by the turbine uniform.

Second, where the engine and the turbine supply power to the same busbars through electric generators, so that the loads on the generators vary in conjunction with each other.

Third, where the engine delivers steam uniformly, but the turbine load fluctuates.

Fourth, where the output of steam by the engine is intermittent or fluctuating and the requirements for steam by the turbine are independently intermittent or fluctuating also.

The use of a regenerator in each of the above cases serves to smooth out the variations between the momentary discharges of the reciprocating engine and the demand of the steam turbine. The regenerator is to the steam-turbine reciprocating-engine combination what the storage battery is to the electrical circuit, or the flywheel is to the reciprocating engine.

Annual Report of Navy's Chief Engineer

The first report of Engineer-in-Chief Com. H. I. Cone, of the United States Navy, is just off the press. Plans and specifications have been prepared and estimates have been made for the machinery. The Bureau has prepared several designs for the machinery of the battleships Wyoming and Arkansas, including a plan for combined installation of turbines and reciprocating engines. In all the designs water-tube boilers, fitted for the use of both oil fuel and coal, were called for; the oil fuel is to be used in conjunction with coal or independently. The question of gasolene motors for installation in naval launches is becoming more important. A number of such motors have been purchased and installed with more or less satisfactory results. The Bureau has designed a four-horsepower two-cycle motor for motor dories and a 32-horsepower four-cycle motor for boats of greater power. Under the Department's authority the Bureau has invited such manufacturers of gasolene motors as desire to avail themselves of the opportunity to submit their motors for a competitive test, which is, we understand, now going on at the navy yard at Norfolk, Va. The report details the work which is being done in the different navy yards and upon the different vessels, and summarizes the activities of the Bureau during the past year. A description of the trials of the scout cruisers, "Birmingham," "Chester" and "Salem," is promised as an addendum to the report.

The oil-burning system installed upon the "Cheyenne" increased the ability to maintain a constant steam pressure and to develop a high power for long periods without tiring out the personnel. Gratifying as have been the results obtained with this system, it is not the most desirable for use in naval vessels on account of the weight and space required for the necessary air compressors (the oil being atomized by compressed air after having first been passed through heaters), and also on account of the desirability of having the heavier vessels so fitted that either oil or coal, or both fuels in combination, may be used as desired, as coal can be obtained everywhere a ship may go, while the ports where oil fuel may be obtained are limited. With this latter consideration in view, the Bureau is fitting in later vessels only such oil-fuel systems as operate by mechanical atomization of the fuel under high temperatures, the necessary air for combustion being supplied by the regular forced-draft boilers of the vessel.

In view of the development of large gas-engine machinery it is recommended that $250,000 of the appropriation for steam machinery be diverted for the purchase and installation of a producer gas-engine plant in one of the colliers belonging to the navy.

At the engineering experiment station at Annapolis, tests have been made upon packing, gage glasses, Parsons turbines, surface condensers, and other apparatus. Tests of a Blake condenser with diaphragms fitted on the principle of the contra-flow condenser were begun and carried on for a time, but discontinued on account of defects observed in the action of the dry-air pumps. In these tests the steam was passed directly from the boiler to the condenser through an expanding nozzle, designed for the purpose. As it might be thought that the diaphragms affected the action of the pump, they were moved before the manufacturers were asked to correct the defect. A series of 26 tests was

made under different conditions of vacuum, and the amount of steam admitted so that the efficiency of this condenser is now well known. The contra-flow condenser will be tried next in the same way, and then the Blake with the baffle plates arranged as in the first test. Finally, the Alberger condenser will be tested.

Since all three of these types were designed from the same data and for the same work, it is expected that much light will be thrown on the present state of condenser design and the formulas used for the same.

In view of the widespread interest in this subject, as shown by the extensive experiments that have been made in recent years, notably in England and Germany, it is much to be regretted that the appropriations available for the experiment station are not large enough to admit of this work being carried on continuously.

Observations on the action of the CO_2 recording apparatus show that it can be used for the purpose of conducting examinations of firemen to determine their skill prior to appointment and promotion. Incidentally, however, it was observed that intelligent and skilful men require an experience of several four-hour watches on a boiler that is new to them before they can get the best results, and, therefore, a practical test of the kind contemplated may prove too tedious for general use in conducting examinations of members of a ship's crew at the navy yard. A modified form of the apparatus can be made for use on shipboard. The design of apparatus for the investigation of corrosion of metals is being worked out. It is planned to ascertain the effect of various preventives at high temperatures corresponding to pressures of 275 pounds.

A standard Riehle oil-testing machine of 25,000 pounds capacity has been installed and will be kept going constantly, testing samples of every lot of cylinder oil furnished to the navy.

An apparatus has been designed and constructed for the testing of sheet packing, including the action of superheated steam thereupon. Another apparatus has been designed and is being constructed, partly at the station and partly at a navy yard for extensive tests of rod packing of various sizes and for various purposes. Thirty-three manufacturers of and dealers in sheet and rod packing have applied to have their packings tested, each proposing to submit from one to six kinds. Tests of water gages have been made, including four types of reflex gages, which although they will fill the requirements of the standard specifications in use by railroad companies, proved unsatisfactory for use on boilers carrying 275 pounds of steam, the best having lasted little over three months, and the others much less time. Those tested broke into countless pieces, or else were corroded by the water until leaks started. Five grades of tubular glasses were submitted and tested under the railroad specification, but only two grades came up with the requirements fairly well.

The Naval Academy is considered by the Bureau and by skilled educators to be the finest school of engineering in the country. The graduates of such a school are naturally fit to undertake subordinate engineering duties of all sorts. For five years, or until they have been promoted above the grade of ensign, they perform duties alternately upon the deck and in the engine room.

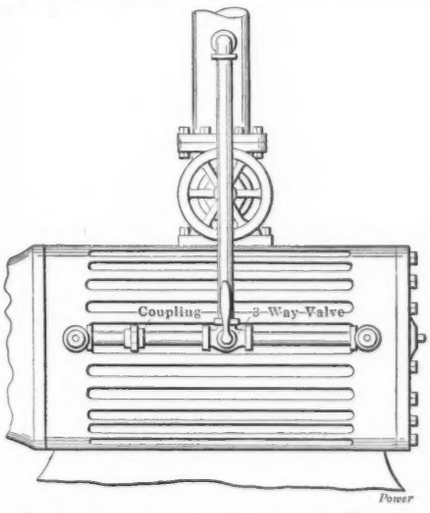
There are today a sufficient number of line officers fully competent to fill the position of senior engineer officer. This fact is evident from the present superior mechanical efficiency of our vessels in commission; from the decreased proportionate amount of the repairs necessary for the maintenance of the ship's machinery in good condition; from the increased proportion of repairs incident to the service that are being performed by the ship's force, and this, with increasing strains on the machinery, due to their now being more frequently operated at or near their designed power than has formerly been the case. The credit for this performance belongs in various quarters. Great credit is due to the enlisted personnel and particularly to those of them who have evidenced such energy and ability as to secure appointment as warrant officers. Obviously, however, the main credit is due to those responsible officers who have had charge of the machinery and to their immediate official subordinates. These have proved their worth and they have justified the legislation of 1899 that made all engineers line officers, and that made all line officers engineers.

Device for Stopping an Engine

On large slide-valve engines, especially when the load is heavy, it is frequently a difficult matter to stop the engine on the quarter, as when steam is admitted past the throttle the crank will either go too far and more steam must be admitted to force it over the center, or it does not go far enough. Therefore, a method which will enable the engineer to admit steam to either end of the cylinder at will should be of considerable advantage to him.

The illustration shows how this can be done. At each end of the cylinder a 1¼-inch hole is tapped and an angle valve attached to the nipple is screwed into each hole. From each angle valve a pipe, to which a three-way cock is screwed, extends so that the cock will come in the center of the cylinder, as shown. From the three-way cock a pipe passes up and connects to the steam pipe above the throttle valve. An angle valve should be placed at the top so that the steam can be shut off from the three-way valve when desired.

When shutting down the engine with this device, the engineer shuts his throttle entirely, and if the engine is going beyond the quarter he throws his three-way valve so that the steam will be admitted at, say, the crank end, in case the engine is



ARRANGEMENT OF THREE-WAY VALVE

running over. This admits steam to the cylinder, stopping the crank in its movement. If too near the crank-end dead center, enough steam can be admitted to reverse the engine until the proper stopping point has been reached. By means of this little contrivance the engineer can save considerable time in stopping his engine at the proper and desirable point.

In a combination of services, such as the modern building requires, part of the supervisory expenses of the engineering staff are necessarily applied to the operation of the heating system, it is fair to assume that the proportion of exhaust steam which is utilized in the heating apparatus carries with it its share of the engine-room charges, and the proper proportion of winter engine-room labor which is to be applied to the heating system becomes that percentage which the utilized exhaust bears to the total steam required for heating.

Reports from Washington regarding the lengthy cruise recently completed by the United States steamer "Cheyenne," in which oil was used as fuel, are to the effect that the vessel was able to steam faster than with coal and that her steaming radius of 1500 miles, which was her limit when burning coal, has been increased by the use of oil to 2300 miles.

POWER AND THE ENGINEER
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Popular and Technical Use of Terms

As a community grows to realize how closely it depends on the laws and facts of applied science, so does the greater importance appear of the correct use of words which have a scientific origin. A modern city which depends on power for its light and its transportation, for its water and its food supply is necessarily in touch with technical problems through its news columns and the reports of its municipal officers. Hence, both parties to such transactions should use the same words with the same meaning and the same set of associated ideas. This necessity becomes particularly significant when a scientific fact or principle becomes the basis of law or municipal ordinance for the guidance and control of the citizens in street or factory.

For example, a misunderstanding of long standing is about the noun elasticity and the adjective elastic. The common and accepted use of these words makes a body elastic to a high degree which yields easily to the impressed force which tends to change its shape. An elastic cushion on the pool table yields far when the ball strikes it, and on the recoil follows the ball long enough to give an effective impulse to it for the rebound. A tennis ball is elastic in common usage, when it rebounds far on striking a surface; a spring bed is elastic when it yields easily to the prominences of the figure resting on it, and hence secures reasonably equal support for all parts of such irregular outline.

To the technical man, on the other hand, the words "highly elastic" or "high degree of elasticity" convey exactly the opposite idea. He has formed the habit of associating with the qualities of his material, an idea of the quantitative values of their constants. Hence, to him, a high elasticity means that the arithmetical values are high for the properties by which he measures or compares the elasticity of bodies. To such a thinker, rubber has a low elasticity and glass has a high one. He expresses his principle mathematically when he states that when a body under test in a testing machine or at work undergoes a change in length or shape, this deformation when multiplied by a proper factor or coefficient will be equal to the stress which produced such deformation; such factor or coefficient he calls the modulus of elasticity of the material, when the test stress and the deformation are each for a unit area of cross-section. Hence, a small deformation compels a large value for the coefficient which expresses the elasticity; or bodies deformed but little under a load are highly elastic. The man on the street by instinct and practice does not agree with this technical usage of the words and the ideas they note.

Another example, and more recent in historic sequence is the term to describe that quality of liquids which is called viscosity. In common use, a liquid such as an oil or molasses is viscous when its particles so adhere to one another that the motion of such fluid molecules over each other or among each other is retarded by this property. Such an oil has a tensile strength as it were, whereby it adheres to a bearing or a journal and can only be separated from contact surfaces or from parts of itself by the exertion of a measurable force. The early scientific investigators into the properties of viscous liquids originated the idea of measuring this property and comparing different fluids by causing a measured weight or volume to pass by gravity through a small calibrated hole while the time taken was observed; or to observe the weight or volume which passed in drops in a given time. Obviously the more viscous the fluid, or the greater its viscosity, the fewer drops would form and pass through the orifice. A low score of drops per unit of time belongs to a highly viscous fluid; water or a limpid hydrocarbon oil will stand at one end of the series; and the simile of "molasses in January" will express the qualities of liquids at the other end. As a small number of drops goes with the greater viscosity, it is roughly true to say that viscosity is inversely as the number of drops. The observer, however, scanning the records of a test, sees a series of numbers corresponding to the numbers of drops per minute; and unless he keeps his mind clear he speaks of the high numbered oils as having high viscosity qualities. The reverse is the actual physical case.

A recent example of the sort of misunderstandings possible from confounding a large arithmetical value of a factor in a denominator with a possession of a quality in a high degree appears in a recent table of results of tests upon

lubricating oils.* The limpid sperm oil and fluid thin machine oil have figures for "viscosity" which place them high in the scale unless an accompanying explanation goes with the table. Real scientific data should be comprehensible to the reader without explanation.

Similarly a column is given for the milligrams of potassic hydrate to be added to the oil per gram in order to make soap with the acid of fatty class in such unit of weight. The greater the quantity of the alkali absorbed, the greater the quantity of acid present. On the face of the record, however, and without full explanation, the implication of the low figure for a saponification constant is that the oil is a soap already, and needs no addition of reagent to make it so. On this understanding an addition of an infinite quantity of alkali in the form of KOH would not make a soap if there was no acid present. It would appear that the practice of the mechanical and physical laboratories needs standardization, so that results shall be comprehensible both to the sophisticated and to the simple, and shall mean the same thing to both.

The foregoing refers only to two terms descriptive of properties of matter. There are many others where exact and popular usage are at variance. What, for example, is the difference between a fire and a flame? What is the definition of a fire, a flame, and smoke? These terms are to be found in national and municipal ordinances; do they mean the same thing to all their users?

Boiler Safety Appliances

About nine out of every ten stationary boilers in this country have the water glass and gage cocks attached to the water column, and about half of these also have the steam gage attached to the water column. Just why the fitters do not go one step further and attach the safety valve to the column and thus make the whole arrangement as dangerous as possible, we have never been able to determine.

We were all made familiar in our childhood with the undesirability of putting all our eggs in one basket, and if we forget that probverb, we had our minds refreshed in that period of life when every boy reads Robinson Crusoe, and there learned of Crusoe's predicament after he had placed all his powder in one place and the lightning struck that place; yet in spite of these admirable precepts, we continue to put nearly all the safety appliances of our boiler in one basket, as it were, and to suspend that basket by small pipes with torruous passages, and then as if we hadn't acted silly enough, we place a stop valve in the upper and lower connection from the water column to the boiler.

The Government recognizes this as bad practice, and the general rules and regulations of the Board of Supervising Inspectors state: "All boilers, except flash boilers, shall be supplied with at least one reliable water gage and at least three gage cocks attached directly to each boiler. When the gage glass and gage cocks are connected to the boilers by a water column, there must be three additional gage cocks inserted in the head or shell of boiler."

The pipes from the boiler to the water column should not be less than one and one-quarter inches and there should be no valves between the column and the boiler. We do not hesitate to call it dangerous to place a stop valve between the safety valve and the boiler, why then should we not consider it trebly dangerous to place a stop valve between the boiler and three safety appliances? Of course, it is easier to close the water column stop valves in case the water glass breaks, than it is to close the small valves at the glass, but, if these valves are kept in order, the difference is not much, and if the difficulty of closing is great, then these small valves should be replaced with quick-closing valves, operated with a chain. The ability to shut off the water column in cold weather to keep it from freezing in the night, does not warrant the use of stop valves, for the mere fact that the column *may* be shut off at night, does not guarantee that it *will* be shut off.

Whenever a pipe carries ordinary feed water it will sooner or later stop up with sediment and scale, so provision should be made for cleaning it, and in the case of the lower connection of the water column the best way to do this is to make every turn with a plugged cross, yet this is the exception rather than the rule. The necessity of providing an ample blowoff for the column is frequently overlooked, and time and time again we find it equipped at the bottom with an one-eighth-inch pet cock.

Not only should the drain from the bottom of the column be of ample size, say, one-half or three-fourths inch, but it should be piped into the ashpit with a lock nut on the inside to prevent the pipe from blowing out. We have seen engineers smile at this recommendation; they look upon it as an unnecessary refinement, but it is not. If there is only a nipple screwed into the blowoff valve on the bottom of the column, every time a man opens that valve he must either scald himself or hold up a shovel as a shield. Neither of these things appeals to him, so he does not blow the column out as often as he would if the job were made easier for him. When the pipe is run into the ashpit and he knows it is locked on the other side, it is then more or less of an amusement to open the valve from time to time just to hear the roar. We wish designers would recognize this principle more than they do, that if what you want the boiler attendant to do is not made easy for him, he will not do it.

*POWER, November 3, 1909, page 902; "Efficiency Tests of Lubricating Oils," by Prof. F. H. Sibley; American Society of Mechanical Engineers *Journal*, November, 1909.

A Newspaper Lie That Might Mislead

A couple of weeks ago the newspapers published a made up story of a $15,000,000 merger of trade papers that included the three papers of the Hill Publishing Company.

The *New York American*, a Hearst newspaper, called up our president, Mr. Hill, said they had the story "from a reliable source" and asked if it was true.

Mr. Hill declared that it was not true, he had not been asked to go into any such combination and would not go if he was asked—yet they published the story—some of the papers even adding at the bottom of the article Mr. Hill's denial. The sensational heading was allowed to stand, however.

This illustrates how much newspapers care for the truth—they only want the sensation.

Now comes a so-called trade paper, *The Paper Trade Journal*, taking us to task for "going into the hands of Wall Street," and abandoning the things that "built up our papers."

This editor has seateatis and edits his paper from a soft chair and his impressions received in doctored form from the daily papers—he did not even take the pains to call up and inquire. He says, "Naturally the whole story is denied by the men concerned" and intimates disaster when subscribers and advertisers learn that outsiders own the paper, etc.

We need hardly assure our readers that this whole story is a malicious falsehood.

That the Hill papers at least have gone into no combination.

That all our stock is owned by employees and one ex-employee of the concern.

That Mr. Hill owns an overwhelming majority.

And intends to keep it.

This concern has been built up on the line of minding its own business and making the best papers that it knows how in the trades it represents.

This policy will be followed in the future as in the past.

We shall "do things" in the publishing line, and "do them first."

This is now the largest independent engineering publishing house in the world—and the whole force from the old man to the last recruit have a pride in keeping it there.

The only "merger" we will ever go into is one that we own and control.

The Cooper Gas Engine

The C. & G. Cooper Company, Mt. Vernon, Ohio, recently decided to join the ranks of the builders of large gas engines. The result is indicated in a general way by the accompanying engravings, which show the chief constructional features of a tandem double-acting engine built by the Cooper establishment.

The new Cooper engine is a double-acting, four-stroke-cycle machine, governed on the constant mixture (varying quantity) principle. Both the air and gas are distributed from the center of the engine so that they travel equal distances and therefore meet with equal resistances in passing to the respective intake valves of the cylinders. The mixture in all cylinders, therefore, is as nearly the same in volume and composition, under all conditions of load, as mechanical provisions can make it. On the same principle the cooling water is introduced into the piston rods at a central point and passes forward through the front piston and piston rod and backward through the rear piston and rod to outlets at the forward and rear ends of the engine. The overhanging counterbalanced type of crank has been adopted.

The bed is of the heavy-duty rolling mill type, with an open top permitting access to the crosshead and easy removal of the cylinder head and piston through the bed. The bed is rigidly bolted to the foundation, while the distance pieces and tail-rod supports, which are of cylindrical construction, rest on base plates in machined ways. The main bearing is of special design. The lower shell rests in a bored seat, and may be easily removed after relieving it of the weight of the shaft. This shell is babbitted and cored for water cooling. The side gibs are provided with wedge adjustment on either side, and are lined with babbitt metal. The cap is babbitted at the ends only, and is used to clamp the quarter boxes and the bottom shell into place. In addition there is a transverse rib on either side of the cap extending the length of the bearing, which provides a retaining wall for the oil, and compels it to enter the bearing above the side gibs. The crosshead is fitted with an improved flat shoe, the top face of which is bored to allow the crosshead pin to aline itself with the crank pin should the latter be thrown out of the horizontal plane by shaft deflection.

All pistons and piston rods are alike

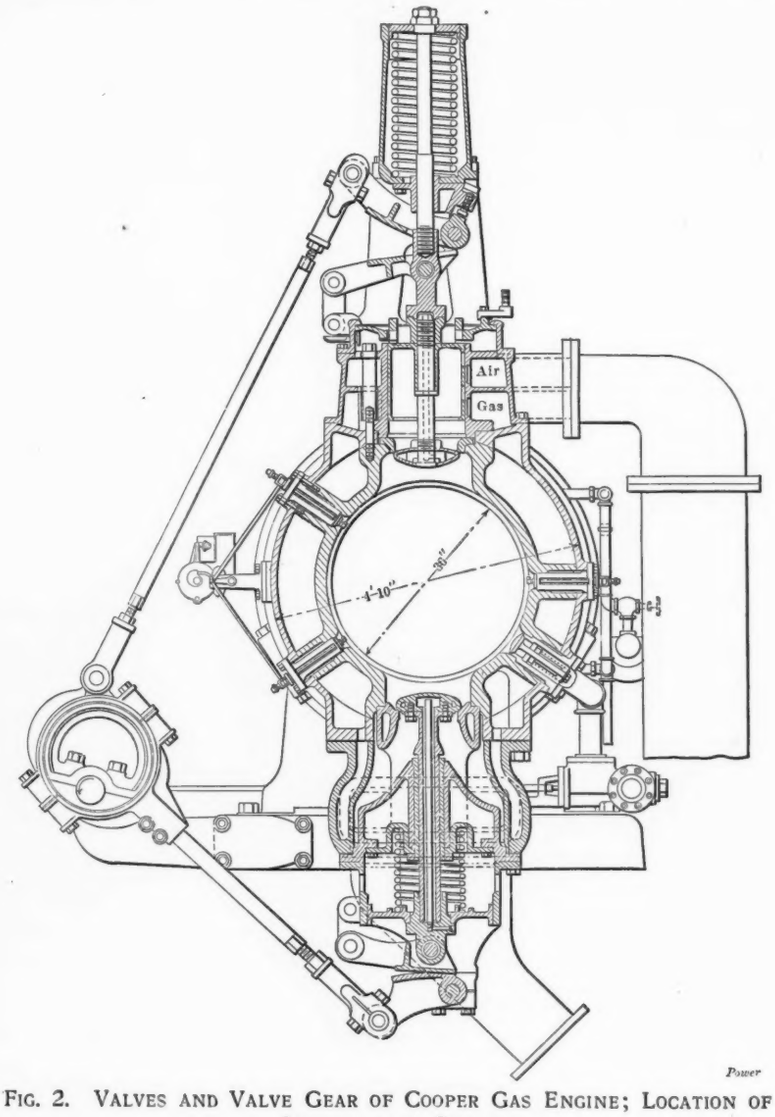


FIG. 2. VALVES AND VALVE GEAR OF COOPER GAS ENGINE; LOCATION OF IGNITER ALSO SHOWN

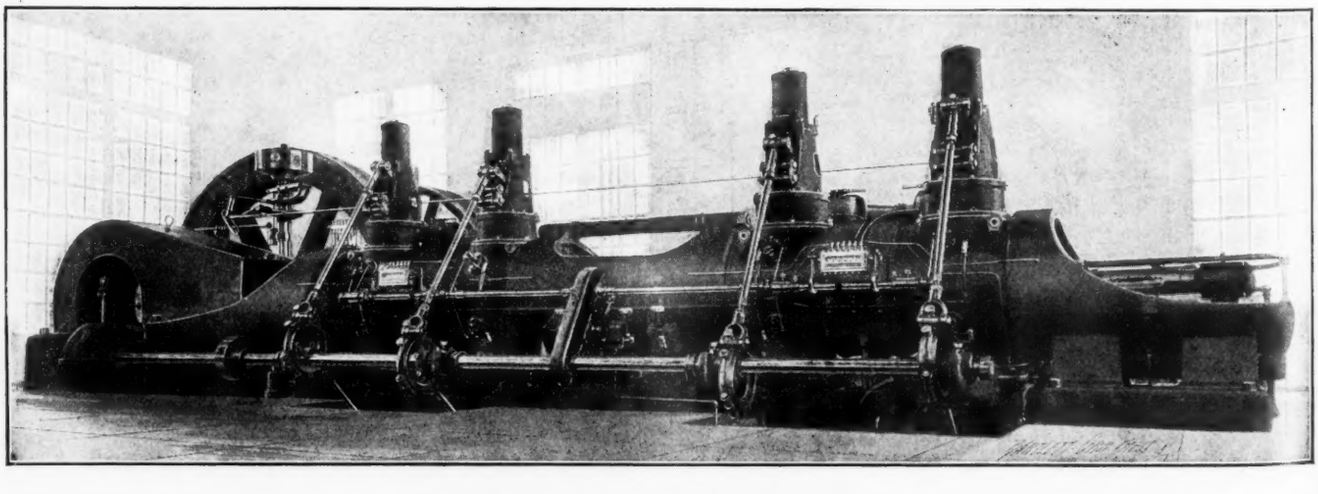


FIG. 1. THE COOPER TANDEM DOUBLE-ACTING GAS ENGINE

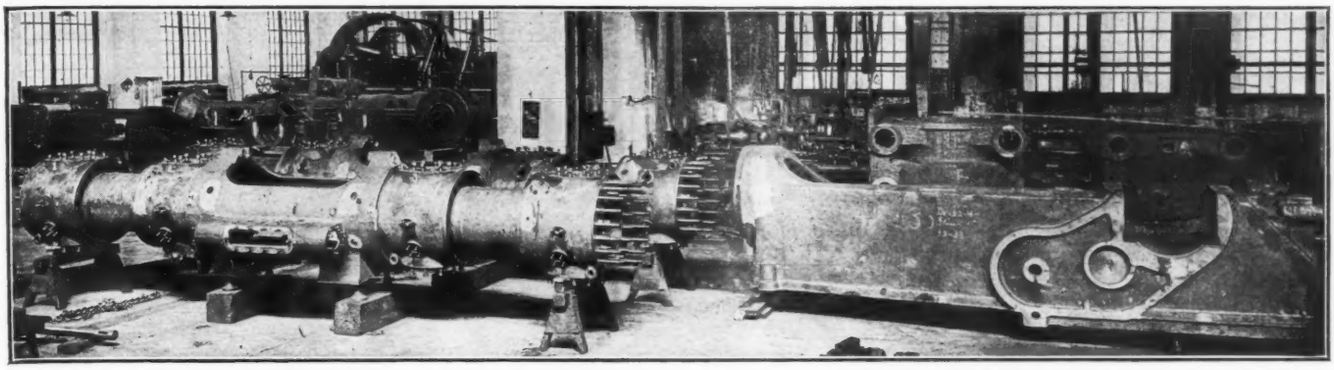


FIG. 3. CYLINDER AND FRAME CONSTRUCTION OF THE COOPER TANDEM GAS ENGINE

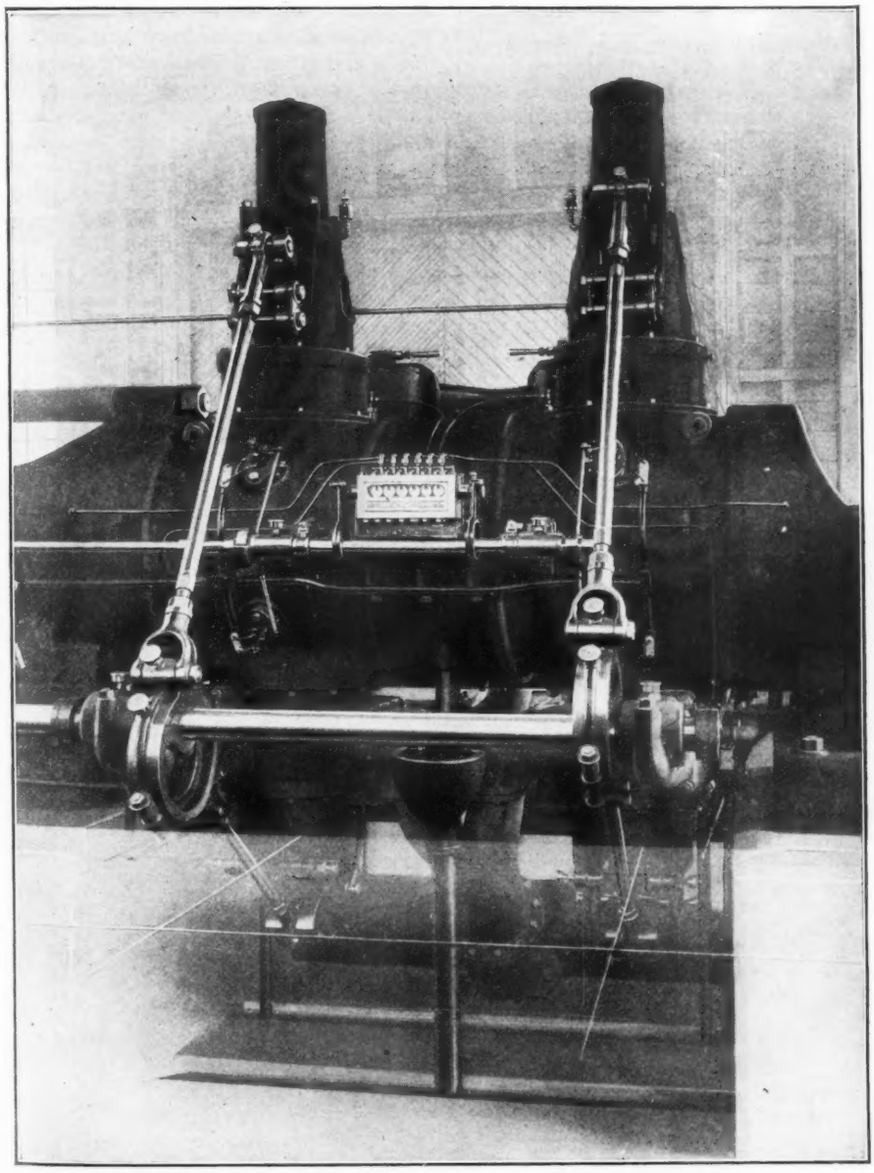


FIG. 4. PERSPECTIVE OF VALVE GEAR, INCLUDING IGNITION AND LUBRICATION MECHANISMS

and are interchangeable without refitting. The pistons contain no ribs and float on hollow rods between the main, intermediate and tail crossheads. The rods are nickel-steel forgings, and are forced into the pistons; they are bored out for water circulation. The cylinders are one-piece barrels, with the inlet and exhaust chambers bolted to them, in order to eliminate cooling strains in the castings. The water jacket is closed at its center by a belt made up in three segments. The cylinders are supported only at the ends by the main bed and guide castings, and the cylinder barrels are free to expand and contract. The exhaust piping is of flexible construction throughout, allowing free movement for expansion and contraction due to changes of temperature.

The ignition system is of the "make-and-break" class with mechanically operated igniters, and two or more igniters are operated simultaneously at each end of each cylinder. The ignition current passes through contacts on a safety stop mechanism which automatically breaks the circuit when the engine speed exceeds 10 per cent. above normal, or the cooling-water supply fails.

The lay shaft, driven by spur and bevel gears, is supported by bearings on the engine bed and base plates; none of the bearings is attached to the cylinders, where they would be affected by temperature changes, nor to the foundation, where it would be difficult to maintain proper alinement. This construction has the additional advantage of permitting the removal of the cylinders without disturbing the lay shaft bearings. The inlet and exhaust valves at each end of each cylinder are actuated by a single eccentric on the lay shaft and the usual system of wiper cam-levers, as illustrated in Fig. 3. The exhaust valve is of the water-cooled type, mounted in a removable cage.

The design of the Cooper engine is under the supervision of Martin A. Thiel, a German engineer who has had many years of experience in the design and construction of large gas engines. The C. & G. Cooper Company is prepared to build these engines in single-tandem and twin-tandem units of from 150 to 3000 horsepower capacity.

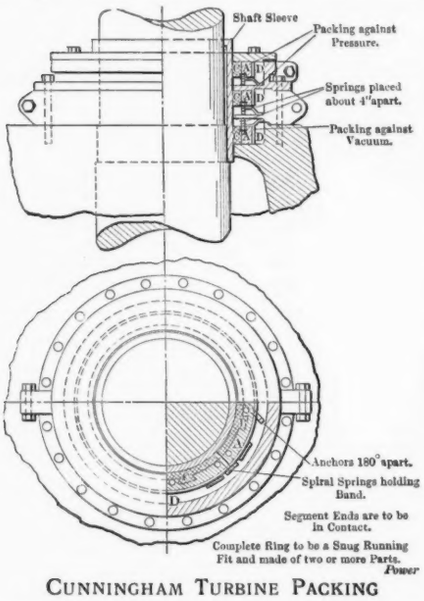
A Rochester (N. Y.) man, says the *Electrical Review*, has recently invented a device called the "telechronometer," which is designed to be attached to a telephone instrument to record the length of the conversation by intervals of a quarter of a minute. No record is made when a call is not effective, and furthermore, when a subscriber is called, his meter does not register unless by previous arrangement with "central." Thus the charge is made on the party who is willing to pay for it.

NEW·POWER·HOUSE ·EQUIPMENT·

What the Inventor and the Manufacturer is doing to save time and money in the Engine Room and Power House

A New Curtis Turbine Packing

In the first stage or compartment of Curtis steam turbines running condensing there is a variable pressure, according to the load, ranging from 15 or 20 inches vacuum on light loads or on starting up, to about 60 pounds pressure on 50 per cent. overload. Air and steam


Shaft Sleeve
Packing against Pressure.
Springs placed about 4" apart.
Packing against Vacuum.
Anchors 180° apart.
Spiral Springs holding Band.
Segment Ends are to be in Contact.
Complete Ring to be a Snug Running Fit and made of two or more Parts.
Power

CUNNINGHAM TURBINE PACKING

leakage around the shaft has been prevented by the use of what is known as carbon packing. Recently a new packing consisting of cast-iron sections lined with antifriction metal running in conjunction with a cast-iron sleeve on the turbine shaft has been put on the market. The illustration shows this packing in plan and elevation.

In operation the steam pressure in the first stage lifts the lower packing ring and presses against the others, making a steam-tight joint. When the load is light or the turbine running with no load the vacuum in the first stage has a tendency to pull the top rings slightly downward, which admits air, but it also seats the lower ring of packing against the face of the packing case, making a tight joint and not admitting air. The following advantages are claimed:

No appreciable wear on the shaft.

No blowing of steam on starting up cold machine or at any time while it is in service.

Higher vacuum on account of reduced admission of air around the shaft over carbon packing.

Additional seal is not needed around shaft where other packings require either steam or water.

The cost of furnishing and installing this packing is not greater than for the carbon packing.

The blowing of dust from the disintegrated carbon is entirely avoided, also the pulling of it into the dry-vacuum pumps, where it causes a gumming of the valves, is entirely eliminated.

The life of this packing is many times that of carbon packing and is years instead of weeks in comparison.

Several degrees lower temperature are maintained on the bearings above the packing, because of there being no steam leaks around the shaft.

The inspection and repairing the packing is very small in comparison with others and it will run many months without any attention whatever.

This packing has been in constant service for a year on units of sizes up to 7500 kilowatts and is giving the very best of satisfaction, both with the packing and its action on the turbine shaft. It was invented by Charles G. Cunningham, 7 Perot street, Kingsbridge, New York.

Nelson Double Disk Tapered Seat Valve

The Nelson vale disk consists of but three parts, two tapered disks and one central wedge. The disks, without any other spreading device than the simple wedge on which they are carried, automatically rock into any position for seating, and it is claimed that the disks work as well when the valve is in a horizontal position as when vertically placed.

Owing to the flexibility of the disk arrangement, any temporary or permanent derangement of the angle of the seat are compensated for, it is claimed. The fact is that, even though one seat does get out of a true surface, due to strain, contraction, expansion, or even though a particle of scale does obstruct the seating of the disk, the action of the wedge applied to the rocking feature of the disk compels the other disk to seat tightly.

It has not only the wedge formed by the angle of the seat, but a compound wedge, due to the action of the inside wedge, and when the disks are in their closed position, their further movement is arrested by reason of the greater bearing surface of the disk against the seat, and a further necessary tightening is accomplished by the movement of the smaller inside wedge. The disks ride on guides that fit in grooves in the valve body and make no contact with the seat until forced "home." Both disks are interchangeable.

In case of sediments getting into the valve when closing, it is forced up between the disks when they are closed, and on the next opening of the valve is carried up with them and washed away.

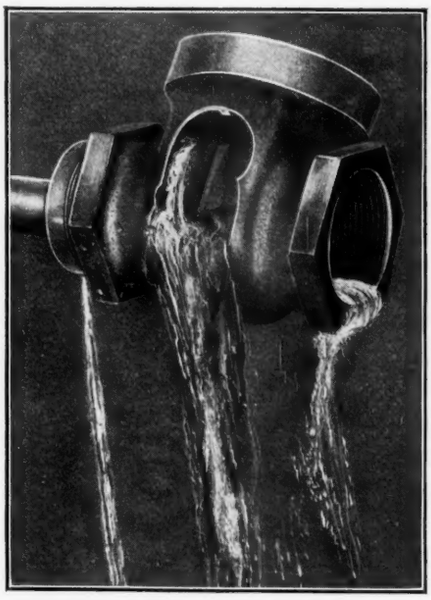


FIG. 1. DISTORTED SOLID WEDGE VALVE SEAT

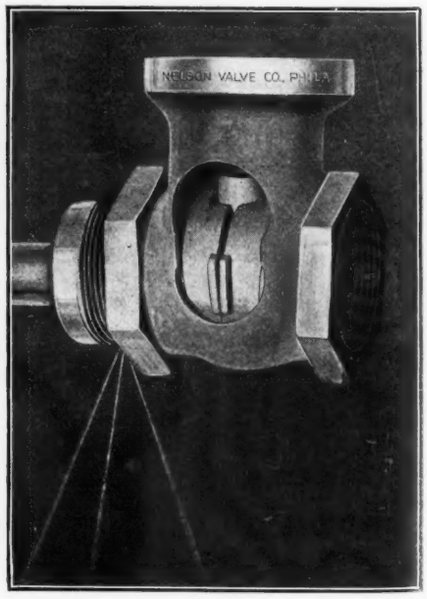


FIG. 2. DISTORTED TAPERED DOUBLE-DISK VALVE SEAT

In case it is desired to regrind one or both disk seats, it is only necessary to remove one of the disks to get working room, and regrinding one seat at a time.

The matter of disk tightness is well illustrated in Figs. 1 and 2. The first illustrates what happened to a solid wedge valve with distorted seats, from a test of 20 pounds pressure, the distortion being 1/32 inch less than in the case of the double-disk valve, shown in Fig. 2. The leak shows that which occurred when tested to 160 pounds pressure, being at the bushings.

The Nelson valve is made by the Nelson Valve Company, Chestnut Hill, Philadelphia, Penn.

Brownell Engine of New Design

The inclosed, splash-oiling, automatic engine, illustrated herewith, has been recently brought out by the Brownell Company, of Dayton, O.

In the design proportions are such as to admit of high rotative speeds, but without producing excessively high piston speeds. These engines are of the side-crank, balanced slide valve type, and clearance has been reduced to a minimum. The steam ports are made short and direct, and are not of large area, or even moderately large, but rather small, as compared with the practice of other builders. They are, however, large enough to give ample admission of steam to the cylinder without wire-drawing effect, it is claimed.

The frames in this design, as will be seen from the illustrations, consist of a modification of the well known Tangye type, the principal change being in the adoption of the Corliss type of crosshead, with bored guides. While the frames are massive, the iron has not been placed in a haphazard way, but great care and study has been exercised in distributing the metal so as to have the greatest strength in line with the greatest strain, and at the same time inclose the running parts so that the splash system of lubricating may be employed.

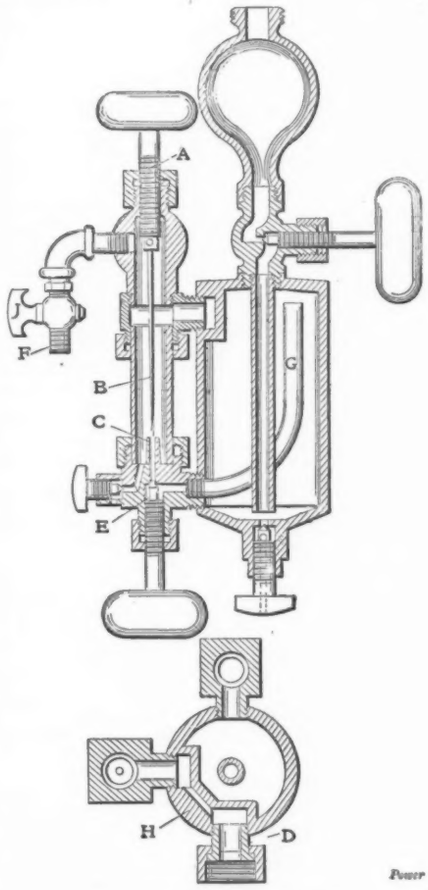
Large openings are provided at the crosshead and crank-pin ends, giving ample opportunity for making adjustments. The main bearings are lubricated from main reservoirs by gravity through tubes which flush the bearing continually. The outer bearing is lubricated by two chains which carry the oil from the reservoir to the bearing, causing it to be flushed with oil at all times. All other parts are deluged in oil by the centrifugal force of the disk, which runs in oil.

The Rites inertia governor is used, and the most direct possible connection is made between it and the valve. The latter is multiported, and consists of thin rectangular castings finished on both sides to an exact thickness, and working between the valve seat and heavy pressure plate, which remove the pressure from the back of the valve, making it balanced in action. Provision is also made for relief in case of a charge of water getting into the cylinder. The cylinder is bolted direct to the engine frame, the end of the frame forming the front cylinder head. This insures perfect alinement with fewer pieces and fewer joints. The piston consists of a single casting cored thin, and braced by ribs, making it strong enough for any legitimate strain. It is shrunk on the rod, and riveted over, in the smaller sizes, while on the larger engines it is held in place by a nut on the end of the rod. Bearing surfaces in the cylinder are liberal, to reduce cylinder wear to a minimum.

The piston is packed by two elastic cast-iron rings, one near each end, while another ring of anti-friction metal is placed in the center. Connecting-rod adjustments are made by wedges, both of which move in the same direction, so that the length of the rods between the centers of pins remains unchanged by wear. All the desirable features of the former types of Brownell engines have been retained in this design, in addition to the improvements which have been suggested by the experience of the builders.

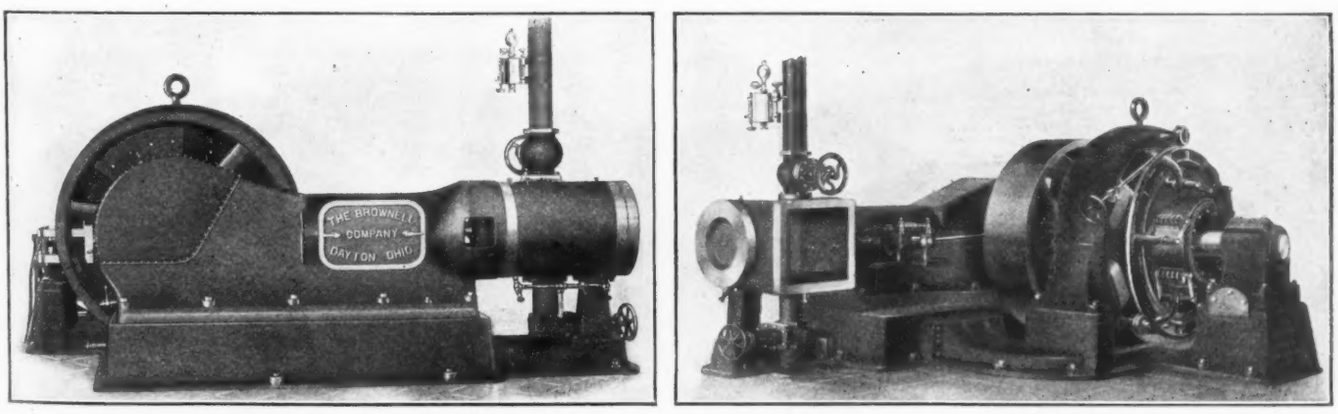
Device for Cleaning and Preventing Lubricator Freezing

The accompanying illustration shows an idea for cleaning out the feed nozzle of a lubricator in case it becomes clogged; also preventing freezing in cold weather.



SECTION OF LUBRICATOR

It consists of the threaded spindle *A* to which a wire *B* is secured. Should the nozzle *C* become clogged, instead of blowing the dirt back into the oil reservoir, the steam connection *D* is shut and the steam valve *E* opened, also the blow-off cock *F*. The steam pressure in the oil cylinder will then clean out the dirt in the tube *G*.



TWO VIEWS OF THE NEW BROWNELL ENGINE

The lubricator can be warmed quickly by shutting the feed valve *E*, when steam will pass out through the oil-pipe cavity *H* and cock *F* to the atmosphere, thus heating the lubricator without allowing water to escape.

The wire *B* is for the purpose of adjusting the feed. It catches the drop of oil just as it emerges from the nozzle but does not extend down into the hole.

In cold weather, when there is danger of the lubricator freezing if it is in an exposed place, it is only necessary to shut off the oil feed and open the cock *F* just enough to permit a little steam to escape, thus keeping the lubricator warm.

These improvements were worked out by John J. Costello, Jr., 405 South Phelps street, Scranton, Penn.

Vulcan Mechanical Fuel Feeder

This furnace stoker has but two internal moving parts, and consists essentially of a coal hopper, with a taper bottom, in which a crushing-feeding cylinder revolves; a distributor which revolves in a chamber below the crusher, and a chain and sprocket wheel for operating the crusher and distributor. Fig. 1 shows a semi-sectional view of the feeder. It is self-contained, and is attached to the boiler front, as shown in Fig. 3.

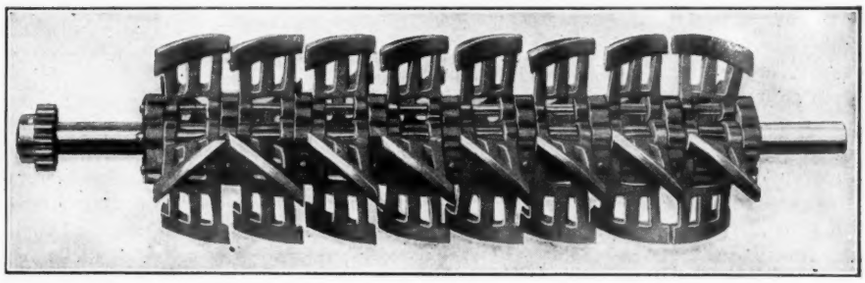


FIG. 2. THE DISTRIBUTOR

Referring to Fig. 1 it will be seen that the fuel is fed to the first moving member or crushing-feeding cylinder by gravity from the hopper above. This cylinder is fitted with teeth, so arranged as to compensate for the adhesion of fuel to the side walls of the machine, which insures the same rate of feed at the ends of the distributing member as takes place at the center. These teeth also furnish a positive feed, and, as a result, wet fuel can be handled just as effectually as dry fuel. The teeth are set spirally about the cylinder from end to end and are alternately long and short, as shown.

The second moving member, or distributor, Fig. 2, is composed of a num-

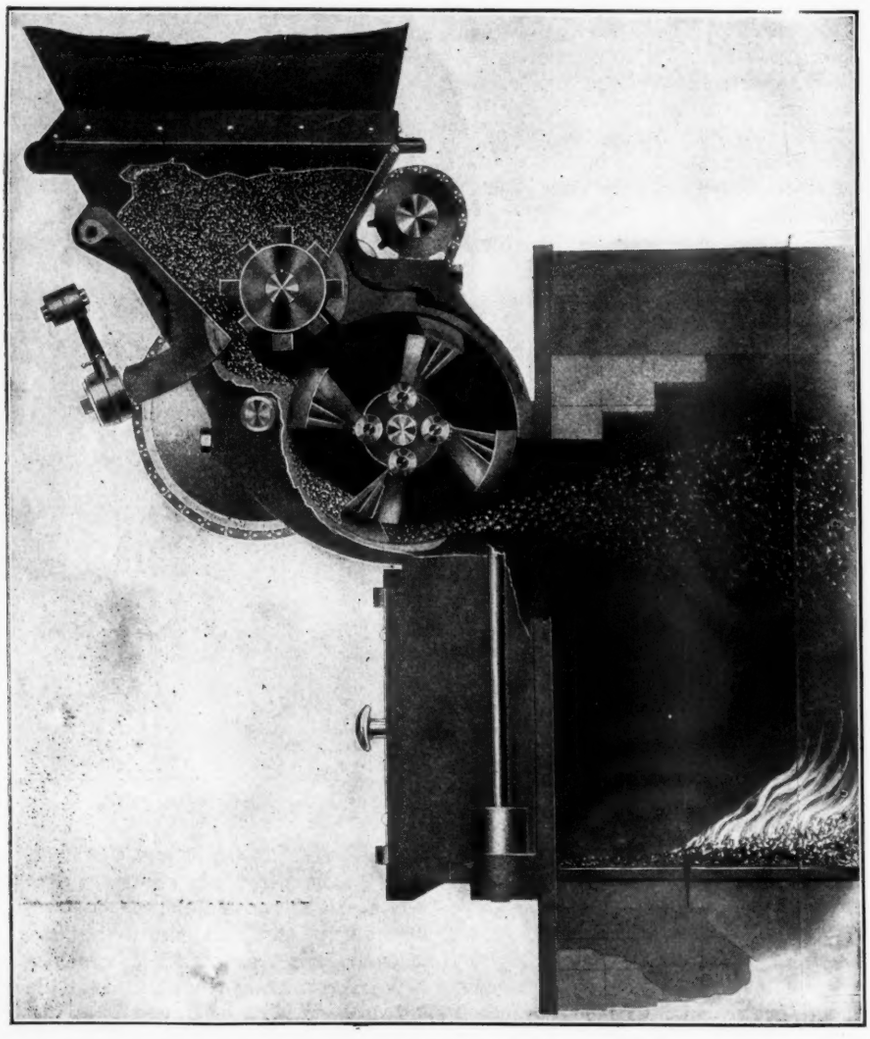


FIG. 1. SEMI-SECTIONAL VIEW OF THE VULCAN FUEL FEEDER

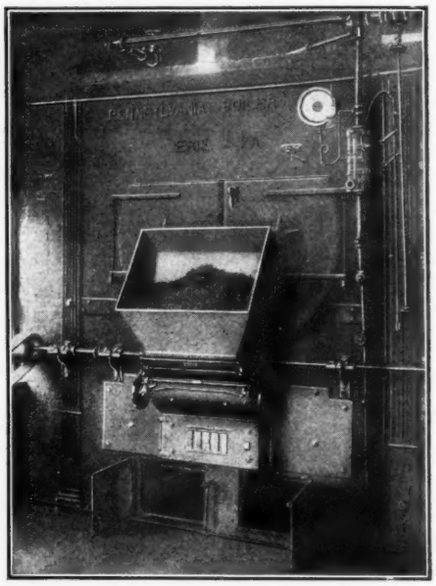


FIG. 3. FEEDER ATTACHED TO A BOILER FRONT

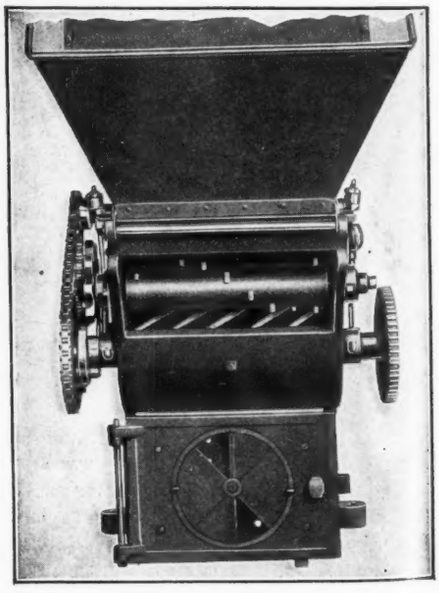


FIG. 4. SHOWING INTERIOR OF FEEDER AND SPROCKET-GEAR ARRANGEMENT

ber of blades which form a helix, each succeeding train of blades being of opposite pitch to the preceding one. This results in automatically delivering the fuel, first upon the right-hand side, and then upon the left-hand side of the grate, as it is discharged from the lip of the discharge plate. The protruding lip beyond the vertical center line and the degree of pitch of the distributing blades are varied so as to secure proper distribution for grates of different lengths and widths. This distributor rotates as indicated in Fig. 1, at a speed of from 350 to 450 revolutions per minute.

Fuel is delivered to the distributor from the projecting lip, forming the shelf just below the crushing cylinder. The amount of fuel delivered to the distributor is regulated by the crusher jaw, which is pivoted at the upper end, as shown, and is adjusted to and from the feeding and crushing cylinder by the arm and ratchet shown on the outside of the hopper. The opening between these points on the crusher jaw and the surface of the crushing cylinder determines the amount of fuel delivered to the furnace, which is controlled from practically nothing up to a good margin above the maximum amount required.

Grooves are provided in the crusher jaw and also in the frame casting at the rear of the crusher cylinder for the passage of the crusher teeth, when the feed of fuel is shut off, or regulated to a very fine adjustment.

When handling slack or crushed coal the crusher cylinder merely feeds the fuel to the distributing member. In case run-of-mine coal is used the lumps are engaged between the crushing teeth and the crusher jaw, where they are reduced in size and then delivered to the distributor.

The distributor blades are held in a radial position by centrifugal force, so that in case any unusual obstruction is encountered at the end of the shelf lip, the blades will swing back on their pivot rods, which will greatly increase the clearance, when the blade following will sweep the obstruction into the furnace.

Fig. 4 shows the driving chain, sprocket wheel and a part of the interior arrangement of the crusher and distributor, also the furnace door which is fitted to the feeder frame. By means of this door the furnace is always accessible for slicing, cleaning or banking the fires, for burning of refuse or, in case of emergency, for feeding the fire by hand.

A very favorable feature about this stoker is that it can be attached to any boiler front, with but slight alterations, the same grate can be used, the ashpit does not have to be deepened, and there is no objectionable protrusion into the boiler room.

This stoker is also available in cases where the draft is poor, because the fuel being continuously fed onto the grate allows of a very thin fire being carried, which increases the effectiveness of the available draft. As there is no movement of the grate, loss of unburned coal sifting into the ashpit is eliminated to only that brought about by slicing and cleaning the fires. The ashpit is cleaned out in the same usual manner. When it is desired to blow the tubes of a horizontal tubular boiler, the hopper, which is hinged, can be dropped down in front of the boiler out of the way.

This fuel feeder is manufactured by the Vulcan Furnace Company, 719 Chamber of Commerce building, Buffalo, N. Y.

American Automatic Damper

This device is designed for the purpose of improving combustion, keeping the tubes and heating surface of a boiler clear of soot, and to permit of using cheap coal. It is proposed to do this by furnishing the proper amount of air over the bed of coal at the proper time, and at the same time bring about an instantaneous mixture with the gases coming from the fuel.

The device is automatic in its operation at each opening of the furnace door, the duration being timed as desired.

The damper consists of an outer shell *A*, Fig. 1, which is supplied with a number of segmental slots *B* at the outer end. In the outer casing is fitted a damper ring which slides on two bolts *C*, on which are springs *D*. This damper ring slides on the inner surface of the casing and opens and closes the slots in the outer casing as it is forced in either direction. The damper ring is provided with a head, which terminates in a central hub *E* surrounding the sleeve *F* which carries the nozzle. This nozzle is provided with a hollow head *G* having restricted orifices at *H*.

When steam is admitted into the damper, it passes in a jet through the crifices into the furnace, and, owing to their restriction, the pressure within the head forces the nozzle inward, carrying the damper rings with it, thus uncovering the segmental slots. Air is thus drawn through the slots by the steam jet, and rushes in through the damper to the furnace. As soon as the steam jets stop, the springs on the bolts return the damper ring to its original position, thus closing the segmental slots and cutting off the air supply.

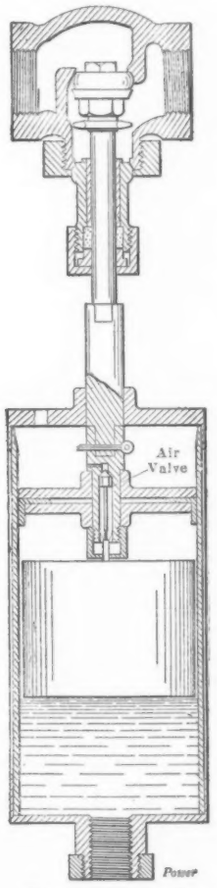


FIG. 2. CONTROLLING FLOAT AND VALVE

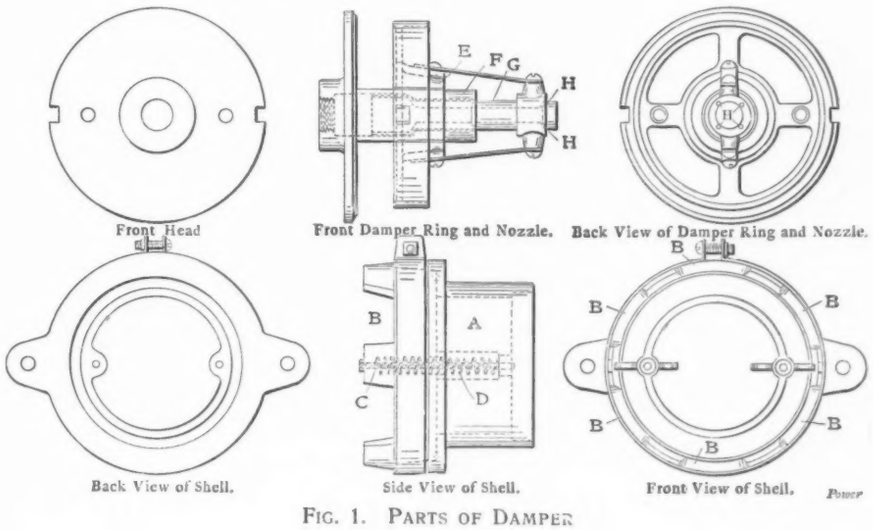


FIG. 1. PARTS OF DAMPER

The steam supply to the damper is controlled by a float in a cylinder, and a steam valve placed in the steam pipe supplying the steam to the damper, Fig.

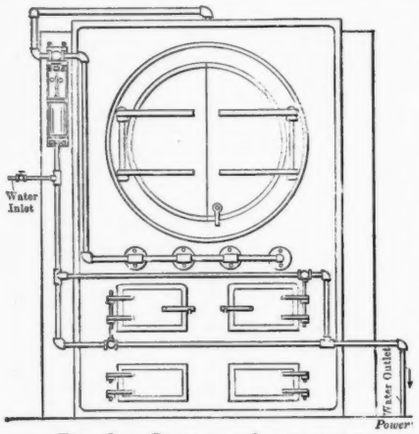


FIG. 3. GENERAL LAYOUT OF CONNECTIONS

2. The lower end of the cylinder is fitted with a pipe connection, and the other connections are made as shown in Fig. 3. When the firemen open one or both furnace doors to replenish the fire, the valve, in the water pipe controlled by that particular door, is opened, and as the pipe is larger than the water-supply pipe, the cylinder is quickly drained, thus allowing the floats to fall, which opens the air valve shown in Fig. 2, and allows the float to descend still further, which opens the valve in the steam pipe, thus admitting steam to the furnace dampers.

When the furnace door is closed, the valve in the water pipe connected to that door is also closed, and as the water is flowing into the cylinder at all times, the float is soon raised and the air valve closed, when the steam-valve disk gradually comes to a seat, thus shutting off the steam supply to the damper. The length of time the steam jet in the damper is allowed to operate depends upon the time it takes to fill the cylinder and lift the float.

This device is manufactured by the Smoke Abater Company, 32-33 Wilcox building, Providence, R. I.

Wood's Feed Water Purifier and Heater

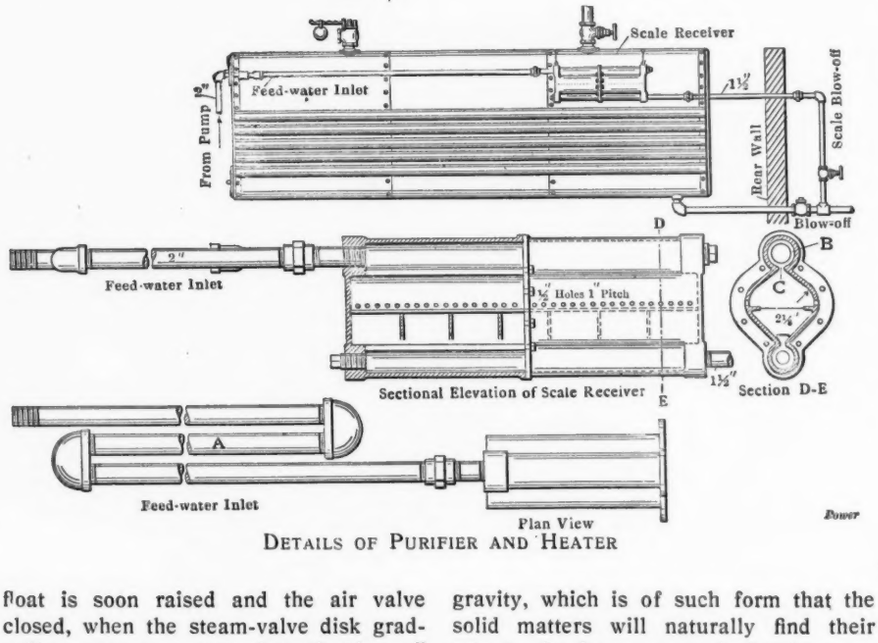
The object of this device is to remove the scale-forming materials from water by subjecting the water to a degree of temperature at which vaporization will take place, when the solid or scale-forming matters are separated and the accumulated materials automechanically disposed of.

The device is placed in the boiler at about the normal water level, as shown, so that the water is discharged through the ½-inch holes which run longitudinally along each side, at the normal water line of the boiler.

The feed water is first introduced into a coil of pipe *A*, which acts as a superheater, and raises the temperature of the water to nearly the temperature of the surrounding body. From this heater coil the water is led to the purifier, and is discharged into it through a circular opening *B*. On the lower side of this opening is arranged a slot *C*, which runs longitudinally from end to end of the purifier; through this slot the water is permitted to drop through the steam space, between the slot and the water line, and by falling through the steam space is raised to the temperature of vaporization. Then the solid matters are precipitated to the settling chamber or the lower half of the apparatus by gravity, which is of such form that the solid matters will naturally find their way to the lower or mud chamber.

This chamber is connected to the main body by a slot running from end to end of the apparatus. From the mud chamber a blowoff pipe is led in which is located a blowoff valve. Upon the opening of this valve the pressure within the apparatus forces the accumulated solid matters out of the boiler. This blowoff valve is opened at intervals, permitting the solid materials to be drawn off, thus preventing too large an accumulation of the same and keeping the water in a pure condition.

In order that the blowoff action may not be confined to any particular portion of the apparatus, the mechanism is subdivided into a number of spaces by properly arranged divisions. In this manner, each section along the whole length of the apparatus, is acted upon independently; the result being that accumulation cannot occur in any portion of the mud drum. Again, in order that any solid matters which have been precipitated to the lower chamber may not be carried over with the feed water, suitably arranged baffles are provided. These baffles are located at right angles to the natural travel of the currents, and just below the openings through which the water is discharged. This purifier is manufactured by John Wood, Jr. & Co., 718 Pennsylvania building, Philadelphia, Penn.



DETAILS OF PURIFIER AND HEATER

Permanent Expansion of Cast Iron under Moderate Temperature

In May, 1909, Crane Company made two straight bars of cast iron, ¼x½ inch, accurately machined. One bar measured 18.336 inches and the other 23.382 inches. These bars were placed in a steam-heated core oven, where there is an even temperature of 325 degrees Fahrenheit. At the end of five weeks the shorter bar had a permanent expansion of 0.003 inch, and the longer, 0.008 inch, the lengths being 18.339 inches and 23.390 inches. In July the bars were transferred to a second oven in which the temperature fluctuates a little, but averages 600 degrees Fahrenheit. After being in this oven 30 days the lengths had increased 0.145 inch and 0.177 inch. The bars were then returned to the oven for another 30 days and gained 0.014 inch and 0.028 inch, respectively, in the second period.

	Inches.	Inches.
Original lengths	18.336	23.382
Gain in five weeks at 325 degrees	0.003	0.008
Gain in thirty days at 600 degrees	0.145	0.177
Gain in thirty days at 600 degrees	0.014	0.028
Final lengths	18.498	23,595

The permanent expansion at a temperature of 325 degrees (equivalent to 82 pounds steam pressure) was very small, but at 600 degrees it equaled in 60 days 0.104 inch per foot on both bars, which is an extraordinary amount. The measurements were taken with the greatest care and carefully checked. —*Valve World.*

INQUIRIES OF GENERAL INTEREST

Questions are not answered unless they are accompanied by the name and address of the inquirer

Expandea Metal

What is meant by expanded metal?

J. B.

Expanded metal is a term that is applied to sheet metal, usually iron or steel that has been closely punched with staggered rows of slots, and then pulled or expanded until the slots assume a diamond shape and the sheet has the appearance of network. Expanded metal is used for reinforcing concrete construction and is often substituted for woven-wire screen.

Expansions in Compound Engine

How can I determine the total number of expansions in a compound engine?

J. B.

The total number of expansions in a compound engine is found by multiplying the number of expansions in the high-pressure cylinder by the cylinder ratio. Suppose for instance that in a compound engine with cylinder diameters of 22 and 42 inches the cutoff takes place at 0.285 of the stroke. The cylinder ratio is 3.61 and the number of expansions in the high-pressure cylinder is 3.5, which multiplied by 3.61 will give 12.63 as the total number of expansions in both cylinders.

Centrifugal vs. Triplex Pump

Can you explain why with a small centrifugal rotary pump, motor-driven, we can pull three or four times as much water out of surface wells as can be lifted with motor-driven triplex pumps of the same capacity, and a practically similar method of installation?

C. W. N.

Is not the difference between the action of the centrifugal and the triplex pump due to the greater capacity of the centrifugal? Pulling out more water as it does it reduces the head in the wells, which induces a greater flow into them from the surrounding water-bearing strata. There is no such thing as a rated capacity of a centrifugal pump except against some specified head while operating at some specified speed. It is probably the case that the rated capacity given is nowhere near the real capacity of the pump under your condition. In the case of the triplex pump, however, the rated capacity will be the actual capacity against any head, provided the speed is equal to the rated speed.

Cold Rolled and Turned Shafting

What is the difference between cold-rolled and ordinary shafting? Which is best and cheapest?

J. H.

Cold-rolled shafting is made by rolling bars of iron or steel, under heavy pressure, between rolls with semicircular grooves in the faces. Much of the so-called cold-rolled shafting is drawn through dies, the process being similar to that of drawing wire. It is supposed to be stiffer and more nearly uniform in diameter than turned shafting. Which is better or cheaper depends entirely upon the purpose for which the shafting is to be used and upon freight or express charges.

Piston Movement of Duplex Pump

If on a duplex pump one piston is at one end of the stroke and the other piston at the other end of the stroke, how can I tell which piston will move first when steam is turned on?

A. G.

This is a position into which the pistons of a duplex pump could not get under working conditions. With the pistons at opposite extremes of travel, both steam valves would be open at the same end of the cylinders. A glance will show whether the steam ports are open on the inner or outer end of the cylinder, and the piston which is at the beginning of the stroke will move first.

Piston and Slide Valves

Why are piston valves used on high-pressure cylinders and slide valves on low-pressure cylinders?

C. O.

Piston valves are balanced and move with little or no friction and are often used on the high-pressure cylinders of marine engines to reduce the friction of the engine and avoid the danger of cutting the valve and seat. In the low-pressure steam chest, as the pressure is much lower, there is less danger of cutting and the clearance may be made much less with a slide valve than with a piston valve, so that the former is preferred.

Horsepower of an Engine

Please give me the horsepower of a 12x26-inch engine running at 120 revolutions per minute under 90 pounds steam pressure.

A. G.

The formula for finding the horsepower of an engine is:

$$H.P. = \frac{PLAN}{33{,}000}$$

where

P = Mean effective pressure on piston in pounds per square inch,

L = Length of stroke in feet,

A = Net area of piston in square inches,

N = Strokes per minute.

The mean effective pressure, or average pressure, as it is sometimes called, is usually figured from a diagram made by the steam-engine indicator, but if we know the initial pressure and the cutoff we can make a close guess as to what the mean effective pressure is. With 90 pounds initial pressure and one-quarter cutoff the mean effective pressure is about 47 pounds; with three-eighths cutoff it is about 63 pounds and with one-half cutoff about 74 pounds per square inch.

The length of the stroke in feet equals, of course, the length in inches divided by 12, the number of inches to the foot; thus,

$$\tfrac{26}{12} = 2\tfrac{2}{12}$$

or, expressed in decimals, 2.17 feet. The area of the piston equals the area of a circle whose diameter is that of the piston. As you no doubt know, the area of a circle is equal to the diameter squared, multiplied by the decimal 0.7854; thus, the area of the piston in this case equals

$$12 \times 12 \times 0.7854 = 113.1$$

square inches. The number of strokes equals twice the number of revolutions. In the case in hand the number of strokes is 240. Now applying the values to the formula we have for one-fourth cutoff,

$$H.P. = \frac{47 \times 2.17 \times 113.1 \times 240}{33{,}000} = 84.$$

In exact work the area of the rod is deducted from the area of the crank end.

Book Reviews

ELECTRIC POWER CONDUCTORS. By William A. Del Mar. Published by D. Van Nostrand Company, New York, 1909. Cloth; 339 pages, 5x7½ inches; 69 illustrations; numerous tables. Price, $2.

This is not an addition to the list of wiring handbooks, but an engineering treatise dealing with the technical and industrial questions which enter into the installation and use of electrical conductors for lighting and power circuits. Chapter 1 is devoted to materials and wire gages; this is followed by a chapter discussing the resistances of wires, cables and networks, skin effect and carrying capacities; the next chapter deals with insulation, and is followed by one on determining the size of wire to be used for given working conditions. This is one of the very good chapters in the book, but it is by no means adequate or entirely satisfactory in method of treatment. The best section of the book is chapter V, relating to the determination of the size of aërial wire to be used for a given stress in the span; this is an abstract of an article written three years ago by Dr. Harold Pender. Another good chapter is No. XII, dealing with the properties of alternating-current circuits. This has the earmarks of having been written by Doctor Pender also. In the seventh appendix the author bewails the "errors made by technical writers in their attempts to express the inductance of a pair of parallel wires," and presents, for the enlightenment of the derelict scribes the fundamental formula of Clerk Maxwell and an incomplete version of the derived equation for inductance per unit of length; the incompleteness consisting of the omission of any reference to the length of the conductors. The correct practical formula is given in Poole's "Wiring Handbook" (published originally ten years ago) and the correct fundamental formula in Bell's "Electric Power Transmission," Thompson's "Elementary Lessons in Electricity and Magnetism," and numbers of textbooks.

"The Warm Air Furnace"

This is the title of a handy reference book containing a compilation of rules and formulas to be used to aid in estimating and installing warm-air furnaces. It is the official handbook on warm-air furnace heating adopted by the National Association of Sheet Metal Workers. It contains about 100 pages of interesting and instructive matter on the subject of hot-air furnaces, purchase, installation and management. The book is published by the Federal Furnace League and is sent free of charge to anyone who will apply to Wilson Ferguson, secretary of the Federal Furnace League, 435 Mint Arcade building, Philadelphia, Penn.

The Joseph Dixon Crucible Company, Jersey City, N. J., announces the publication of "Graphite as a Lubricant," Eleventh Edition, being the edition for 1910. Every two or three years the company republishes this booklet. The present edition is more compact than its predecessor, and the engineer will find the newest edition of considerable value to him, since it deals especially with the lubrication and treatment of power-house machinery. A free copy of the booklet will be sent free to anyone interested in machinery and better lubrication.

Obituaries

After an illness of only six days, Richard Thompson succumbed to an attack of pneumonia at his home in New York City on Thursday, December 30, 1909. Mr. Thompson was born at Duhat, county Monahan, Ireland, in 1843. He

THE LATE RICHARD THOMPSON

came to this country when he was sixteen years of age and engaged in the manufacture of wire, but soon became interested in a line of engineering supplies, and for half a century has been a prominent figure in that trade. It was, however, in connection with the steam-engine indicator that Mr. Thompson was best known to the engineers of America. It was among the goods which he represented and to it he devoted his especial attention, lecturing upon it widely among the engineers associations and eventually producing an instrument of his own design. Numerous patents bear testimony to his industry and genius. A planimeter was one of his latest productions. He was a member of many engineering societies, including the American Society of Mechanical Engineers, and his work with the indicator did much toward popularizing the use of that instrument. Mr. Thompson has been located on Liberty street for 35 years. His son, Richard E. Thompson, will continue the business at the same address.

H. Lansing Perrine, 63 years old, died on Friday night in his home at Allenhurst, N. J., of pneumonia, after an illness of one week. He was born in Freehold, N. J., and was a well known mechanical engineer. For the last two years he had been with the Scranton Steam Pump Company. During the civil war he served as chief engineer on the "Western World" on the James river. He had written several articles on the early steamers and was a member of the G. A. R. His wife and one son survive him.

Personal

George M. Brill and Horace C. Gardner, of Chicago, announce the formation of a partnership under the name of Brill & Gardner, for the purpose of continuing the engineering and architectural practice heretofore conducted by Mr. Brill, who has been engaged for many years in constructive engineering work and for 12 years has specialized in the design of complete manufacturing and power plants. For over 20 years Mr. Gardner has held the position of manager of the construction and mechanical departments of Swift & Co.

C. V. Kerr, formerly chief engineer for the Kerr Turbine Company, of Willsville, N. Y., has resigned his position as an employee of that company and will enter upon new connections soon after the first of the year.

Samuel A. Chase, who for the past few years has been with the Westinghouse Electric and Manufacturing Company in their New York sales office as a special detail and supply salesman, has recently resigned to accept a position with the White Investing Company, of New York City, a financial investment company handling stock of many different organizations. Since January 1, Mr. Chase has been in charge of the Chicago office of the White Investing Company, having exclusive territorial rights in North and South Dakota, Minneapolis, Iowa, Illinois and northern Indiana.

Annual Meeting of Indiana Engineering Society

On January 13, 14 and 15 the Indiana Engineering Society will hold its annual convention at the Denison hotel, Indianapolis, Ind. Some of the papers to be presented are as follows: Stream Pollution, by Charles C. Brown, Prof. R. L. Sackette and H. C. Jordan; Arches, by Prof. Malver A. Howe; Some Types of Reinforced Construction, by E. E. Watts, and a number of other interesting papers. There will also be an exhibit of engineering materials.

Boiler Explosion at Reading, Penn.

Early in the morning of December 29 a serious boiler explosion occurred at the new plant of the Metropolitan Electric Company, in West Reading, Penn. The explosion resulted in the death of five men, who were thrown several hundred feet from the boiler house. It is reported that one of the bodies was blown over a high tree and found lying along the Pennsylvania railroad track about 200 feet from the scene of the explosion. The others were also found at a considerable distance from the plant and all were badly mutilated. The boiler was literally torn into pieces and the shack containing the boiler was badly wrecked.

It appears that the night watchman had just left the plant at 6:50 a.m., and the day force had arrived when the boiler exploded. It is fortunate that a larger number of the employees were not included among the fatalities. According to one report the explosion occurred in one of the 40-horsepower boilers used to generate steam for the concrete mixer. The same report says that the boiler had been recently overhauled and given a new set of flues, so that, apparently, it was in good condition. Further particulars of the explosion will be given as early as possible.

Society Notes

On Tuesday evening, December 28, Fred L. Johnson gave an illustrated talk on "Compression" before Phoenix Association, N. Y., No. 24, N. A. S. E.

On January 11 the American Society of Mechanical Engineers will hold its usual monthly meeting and devote the evening to the subject of lubrication.

Fred R. Low gave the members of New Jersey No. 5, N. A. S. E., an interesting talk on "Heat" on Wednesday evening, December 29, in the association rooms at Odd Fellows hall, Hoboken, N. J.

On Tuesday, January 18, T. Commerford Martin, past editor of the *Electrical World*, will deliver a lecture on "Features of Electrical Development" before the Stevens Engineering Society. The lecture will be held from 4:10 to 5:10 p.m. at the college in Hoboken, N. J. All interested in the topic are cordially invited.

Arthur Ritter, of the American Blower Company, gave an illustrated lecture on "Blower Equipment and Systems" before the Modern Science Club, of Brooklyn, on Tuesday evening, December 28, 1909. He described the various types of fans and blowers now on the market and explained the uses to which each type was best adapted. His remarks were closely attended by a large number of members and friends.

The eighth annual entertainment and ball of the Combined Associations of the N. A. S. E., of Manhattan and Bronx, will be held at the Grand Central Palace, Lexington avenue and Forty-third street, New York, on the evening of January 15. The various committees have been devoting every effort to make this the best affair of its kind ever given—the entertainment preceding the ball promises to be well worth seeing—and from the sale of tickets a very large attendance is assured.

On Friday evening, January 21, the engineers of Boston and vicinity will tender a banquet at the Hotel Somerset to the presidents of the American Society of Mechanical Engineers, the American Society of Civil Engineers, the American Institute of Electrical Engineers and of the Boston Society of Civil Engineers and other distinguished guests. Following the banquet, a description of the battleship "North Dakota," illustrated with lantern slides, will be presented. The president of the Boston Society of Civil Engineers, which has already accomplished considerable work in this direction, will speak upon the erection at Boston of an Engineering Societies' Building similar to that at New York.

The Cranes, father and son, of No. 15, Waterbury, Conn., N. A. S. E., are at present domiciled in Duluth—the Zenith city. W. E. Crane, senior, was recently introduced in No. 3, Minnesota, N. A. S. E., by Past State Deputy W. D. Tomlin in some kindly well chosen words expressing the pleasure of the Duluth association in welcoming such a veteran engineer. Mr. Crane is making his presence felt in this busy city among the engineering fraternity. The son is engaged with the big hydroelectric-power company as one of its electric engineers. There are 230,000 horsepower in sight which this company is developing as power is demanded; 75,000 horsepower is being worked at present and the work is being pushed all the time.

About forty members of the Modern Science Club, of Brooklyn, were guests of Harry P. Wood, chief engineer of the Brooklyn Edison Company, during their visit to the Gold street generating station on Thursday evening, December 30, 1909. This station has recently been remodeled and now contains turbine-driven generators. At present, the equipment consists of four 7500-kilowatt machines; two are of the Allis-Chalmers, horizontal type, one is of the Westinghouse-Parsons design and one a Curtis vertical turbine. There is space for several additional units. Mr. Wood showed the club members many of the interesting features of the plant. Those present unanimously agreed it was an evening pleasantly and profitable spent.

Engineering Societies

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., Jesse M. Smith, New York, N. Y.; sec., Calvin W. Rice, Engineering building; 29 West 39th St., New York. Monthly meetings in New York City. Spring meeeting at Atlantic City, about June 1; exact date later.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Wm. C. L. Eglin, Philadelphia, Pa.; sec. and treas., John F. Gilchrist, 139 Adams St., Chicago, Ill. Association headquarters, 29 W. Thirty-ninth St., New York.

ENGINEERS' CLUB OF PHILADELPHIA

Pres., W. P. Dallett; sec., W. P. Taylor, 1317 Spruce St. Regular meetings 1st and 3d Saturdays.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Navy Dept., Washington, D. C. Pres., Rear Admiral John K. Barton (retired) U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, Cleveland, O.

WESTERN SOCIETY OF ENGINEERS

Pres., Andrews Allen; sec., J. H. Warder, 1737 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., George T. Barnsley; sec., E. K. Hiles, 803 Fulton building, Pittsburg, Pa. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Louis A. Ferguson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES

Pres., A. L. Merriam, Oswego, N. Y.; sec., C. H. Sembower, Reading, Pa.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August, 1910.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 525 Manhattan building, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next convention, Philadelphia, Pa., June, 1910.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio.

MASTER STEAM BOILER MAKERS' ASSOCIATION

Pres., J. H. Smyth; sec., Geo. M. Clark, 1337 N. Maplewood Ave., Chicago, Ill.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee, Peoria, Ill. Next convention, Denver, Colo., September, 1910.

NATIONAL DISTRICT HEATING ASSOCIATION.

Pres., A. C. Rogers, Toledo, O.; sec. and treas., D. L. Gaskill, Greenville, O.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATION.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, Washington, D. C., January 17-21, 1910.

Business Items

The Utica Fine Yarn Company, Utica, N. Y., is building a new factory. The power equipment will be furnished by Allis-Chalmers Company and will consist of one 937-k.v.a., 600-volt, 60-cycle, 3-phase alternator direct connected to a steam turbine running 3600 revolutions per minute when receiving steam at 175 pounds pressure and discharging into a 28-inch vacuum referred to a 30-inch mercury barometer. The vacuum will be maintained by a Tomlinson type "C" condenser. Excitation will usually be by a 22½-kilowatt, 850-revolutions per minute, 120-volt motor generator set provided with an oil-immersed potential starter. There will also be a 17½-kilowatt, 120-volt exciter, driven by a 5x5-inch duplex, double-acting automatic engine running 550 revolutions per minute.

The visit of engineering students throughout the Central West, has come to be an annual affair at the works of the Dodge Manufacturing Company, at Mishawaka, Ind. The journeys begin at the close of the year, usually the latter part of November or early in December, special trains being chartered for the occasion. On December 3, the junior and senior engineers of Purdue University, Lafayette, Ind., were taken care of by the company. Special exhibits and explanatory methods were so arranged that the students could see clearly every step in the manufacture of "Independence" wood split and "Standard" iron split pulleys, friction clutches, bearings, fly and balance wheels, sheaves, hangers, elevating and conveying equipment, the "Eureka" water softeners, etc. Wood pulley parts in every stage of construction were shown as well as special molding machines and pattern systems, developed by the Dodge company at a cost of more than $50,000, for making iron pulleys. Pattern and sweep molds, coring schemes, etc., were arranged in the foundry in such a way as to convey a clear idea of how the largest wheels and the smallest standard parts of transmission goods were molded and cast. The use of rope transmission for power distribution from a central point to widely scattered departments was exhibited in the extensive arrangement at the Dodge works. The tell-tale scheme for detecting and announcing the slightest fraying of rope or splice, and the electric let-off device for releasing a clutch and stopping a department drive from any place in the shops, as also the value of the friction clutch itself in the subdivision of power, all were demonstrated by actual illustration. The difference between treated water and the raw supply was made of interest in the work of the "Eureka" water-softening apparatus for boiler feeding and industrial purposes. In this way these young students learned certain practical facts about transmission machinery and methods—facts that could not be derived from any college curriculum. The boys were given a dinner by Melville W. Mix, president of the Dodge Manufacturing Company, at the new Mishawaka hotel, of which he is also the head.

New Equipment

The Manhattan Oil Company, Omaha, Neb., is to erect a new boiler house.

The Murphreysboro (Tenn.) Water Company will improve its filtering system.

The Shurtleff Company, Janesville, Wis., will erect a cold-storage plant to cost $10,000.

The electric-light and water plant at Bellevue, Iowa, was burned. Loss, about $6000.

The Merchants Cold Storage Company, Minneapolis, Minn., will erect a four-story addition.

The Washington County Light and Power Company, Stillwater, Minn., will increase its facilities.

The Swift Company has taken out a permit for the erection of a refrigerating plant at Newark, N. J.

The city of Greenville, Tex., erecting a new electric-light plant. Building and machinery will cost about $80,000.

The Lifter Ice Cream Company, Philadelphia, Penn., is having plans prepared for a new three-story building.

An auxiliary plant of the Lee Electric Light Company, at East Lee, Mass., was burned, causing a loss of $10,000.

The capacity of the municipal power plant at Quincy, Fla., is to be increased. Specifications are being prepared for new equipment.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids January 11 for two gasolene engines (schedule 2089), oil storage and distribution system (schedule 2091); February 1—Twenty-one-horsepower engine (schedule 2114).

Help Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

AGENTS WANTED to sell Buckeye lubricating compound on a commission basis. Buckeye Compound Co., Pittsburg, Penn.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

AGENTS WANTED—23 FOR DIRT cleans everything; every engineer needs it. Send 10c. for can; agents wanted everywhere. Corliss Chem. Co., 403 S. 12th St., St. Louis, Mo.

THE GAS ENGINE is the power of the future. Wanted: A sales manager experienced in this line with some capital to join us in pushing the sale of gas producers and engines; we have the factory and equipment; large business in sight; this is a fine opportunity. Address Box 101, POWER.

AGENTS WANTED—Agents to represent us in the sale of Cassco bar and ring metallic packing, a metallic packing which costs about the same as soft packing and will wear from seven to ten years; can be handled as a side line very acceptably; some territory still open for steam specialty men to handle the Erwood positive duplex blow off valve and the Erwood reversible automatic non-return valve. Address Triumph Engineering & Supply Co., 253 La Salle St., Chicago, Ill.

Situations Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

MANAGER, sales manager, district manager, electrical or mechanical lines; 20 years' experience. Harwood, 20 Howard Place, Jersey City.

POSITION WANTED by technical graduate, expert in combustion, furnace design and value of different coals. F. J. C., POWER, 355 Dearborn St., Chicago.

CHIEF ENGINEER, 15 years' experience in large water, light and ice plant, desires to change location; employed by Hinton Water, Light & Supply Co. Address H. A. Day, Hinton, W. Va.

WANTED—A position as engineer in factory or electric power plant; experienced with a.c. and d.c. generators, pumps and boilers; can furnish reference as to charcter and ability. Box 103, POWER.

SITUATION WANTED by a gas engineer experienced on two and four cycle gas engines, also on suction and pressure producers and can furnish first-class references. Address "C. W. 86," care POWER.

MECHANICAL ENGINEER, theoretical and practical, with office in Chicago, established 1893, well acquainted among manufacturers, etc., desires to represent outside firms in the selling and installation of their products; references furnished. Box 99, POWER.

Miscellaneous

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS secured. C. L. Parker, Solicitor of Patents, 4 McGill Bldg., Washington, D. C.

WANTED—One 150 horsepower Corliss engine in good condition. The Edgerton Electric Lighting System, Edgerton, Ohio.

MACHINES DESIGNED; manufacturing drawings made. E. J. Paque, designer of special and automatic machinery, 119 Opera Place, Cincinnati, O.

ANY FIRM or engineer in charge of a steam plant that is troubled with scale in the boilers can get absolutely free, the best indicator and reducing wheel made, with velvet-lined mahogany case. For particulars, address Great Lakes Chemical Works, Manitowoc, Wis.

The annual meeting of the stockholders of the Hill Publishing Company, for the election of directors for the ensuing year and for the transaction of such other business as may properly come before the meeting, will be held at the office of the company, in the Hallenbeck building, 497-505 Pearl street, Borough of Manhattan, New York City, N. Y., on Tuesday, January 25, 1910, at 12 o'clock noon.
Dated, New York City, December 6, 1909.
Robert McKean, Secretary.

For Sale

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—Three Bundy return traps and two receivers used a short time; good condition. Box 100, POWER.

FOR SALE—Foundry and machine shop with rail connections, cranes and equipment suitable for medium to heavy work. Address Box 102, POWER.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—One tandem, compound McIntosh & Seymour engine, 1000 to 1600 horsepower; in good condition; shaft ready for an a.c. or d.c. generator. Apply to H. P. Wood, Brooklyn Edison Co., Brooklyn, N. Y.

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